Appendix H

New Technology for Improving System Capacity

H.1 Background

The demands on the National Airspace System (NAS) are continuously growing, and this increasing demand must be accommodated with limited airport and airspace capacity. New and changing technologies provide the opportunity to dramatically improve the efficiency and effectiveness of the NAS. One of the major purposes of the Research, Engineering, and Development (RE&D) program is to develop and exploit technologies that will increase system capacity and fully utilize existing capacity resources, while maintaining or improving the current level of safety.

H.1.1 Major Accomplishments

- Approved instrument approach procedures for triple parallel runways at 5,000 feet apart.
- Completed testing of Airport Movement Area Safety System (AMASS) at San Francisco International Airport.
- Successfully demonstrated automatically controlled runway status light system at Boston Logan International Airport.
- Developed standards for stop bar system for controlling aircraft movement in low visibility.
- Developed the Traffic Alert and Collision Avoidance System (TCAS) which will be installed on all airliners operating in the United States.
- Demonstrated digital Automated Terminal Information System (ATIS) at three airports.
- Began field development of Center-TRACON Automation System (CTAS).
- Implemented Converging Runway Display Aid (CRDA) at Lambert St. Louis International Airport.
- Approved procedures for 5,000 certified Global Positioning System (GPS) non-precision approaches at 2,500 airports in the United States.
- Completed avionics certification standards for Global Navigation Satellite System (GNSS).
- Completed avionics certification standards for supplemental GPS use over the ocean.
- Provided regulatory and implementation materials in support of 1,000 foot vertical separation standard in the North Atlantic.
- Developed flexible track generation and traffic advisory capabilities in the Central Pacific.
- Validated innovative deicing protection technologies and certification techniques.
- Established multi-agency program to provide real-time weather information to pilots and controllers.
- Demonstrated improved thunderstorm forecasting capability.
- Completed ground testing of airborne humidity sensor.
- Completed flight experiments of wind shear detection system.
- Developed traffic management display system.
- Began implementation of automated demand resolution functions.
- Delivered testbed for digital voice communications.
- Developed prototype two-way data communications system for ATC clearances.
- Established predeparture clearance procedures at 31 airports.
- Developed a long- and short-term pavement research plan.
- Completed development of layered elastic theory for pavement design.
- Completed design of pavement testing machines.

The FAA has developed a description of the Air Traffic Management (ATM) system of the future that has broad support from the RE&D Advisory Committee, aviation system users, and the aviation industry as a whole, including the international community through the International Civil Aviation Organization (ICAO). A strong RE&D program is essential to bringing this vision of the future to operational reality. Among the elements of the ATM system of the future are:

- Satellite communications technology for air-to-ground communications over oceans and sparsely populated areas.
- Satellite navigation systems to provide location information over oceans and less developed parts of the world and provide high quality approach guidance to any runway end anywhere in the world.
- ATC digital data link communications to connect aircraft systems with ATC automation systems and increase safety by reducing misunderstood communications.
- Airborne collision avoidance systems, in themselves a major safety tool, have the potential to create, in the cockpit, a valuable picture of the traffic situation around the aircraft. Working with the ATC system, these capabilities will lay the basis for a system having greater capacity and enhanced safety.
- Flight management systems, increasingly available in modern transport aircraft, can facilitate major improvements in working with ATC to create optimal flight profiles.
- Air traffic management and control automation technology will create major improvements in strategic flow management across the country, providing users with more direct routes. Automation in terminal airspace will significantly increase capacities while reducing controller workload.
- Better air traffic surveillance systems, e.g., Mode S secondary surveillance radar, satellite and terrestrial-based Automatic Dependent Surveillance (ADS), new surface surveillance tools, and fast-scan radars, will revolutionize the ability to track multiple aircraft positions.
- Better ways to acquire and use weather and environmental data are on the horizon. Major strides have been made in detecting wind shear, gathering winds aloft data, and forecasting severe storms. Reducing the impact of wake vortices, a detriment to airport capacity, is possible.
- Airway Facilities Operation Control Center will improve the operational integrity of all fielded systems.

The projects described above are explained in detail in the following sections: *Capacity and Air Traffic Management Technology; Communications, Navigation, and Surveillance; Weather; and Airport Technology.*

H.2 Capacity and Air Traffic Management Technology

H.2.1 Advanced Traffic Management System (ATMS) (021-110)

Responsible Division: ARD-100
Contact Person: Stephen M. Alvania, 202/267-3078

Purpose

To reduce delays and enhance operating efficiencies through a highly automated traffic management system.

The ATMS program is the FAA research and development effort in direct support of the operational Enhanced Traffic Management System (ETMS). The ATMS is used to investigate automation and technology applications that will enhance the operational capabilities of the FAA Traffic Management System. The ATMS program is structured as the development of a sequence of evolutionary flow management capabilities which, once determined to be operationally beneficial, migrate to the operational ETMS system through a common development/testbed facility. The ATMS evolutionary stages currently defined are: Aircraft Situation Display (ASD) to display the traffic situation; Monitor Alert (MA) to automatically alert flow managers to projected congestion and delay conditions; Dynamic Special Use Airspace (DSUA) to integrate military airspace planning into the civil flow management process; Automated Demand Resolution (ADR) to generate alternative flow management strategies that deal with the projected conditions; Strategy Evaluation (SE) to evaluate the operational impact of those alternative strategies; and Automated Execution (AEX) to automatically select and implement the "best" strategy.

Program Milestones

The Aircraft Situation Display (ASD) and Monitor Alert (MA) functions have been deployed as part of the operational ETMS at the Air Traffic Control System Command Center (ATCSCC), all ARTCCs, and selected TRACONs.

Prototype Automated Demand Resolution (ADR) algorithms are being designed and incorporated into the ATMS testbed for evaluation. During FY93 and FY94, these algorithms were tested and refined. Migration to the ETMS is expected in FY95.

The development of the Strategy Evaluation (SE) function began in FY93 with migration to the ETMS anticipated in FY96.

The development of initial Dynamic Special Use Airspace (DSUA) algorithms began in FY93 and will continue with migration to the ETMS anticipated in FY97.

The Automated Execution (AEX) function will provide the data communications that will support the ADR and SE functions. AEX will be significantly more sophisticated than previous stages. Development of this function will occur concurrently with the ADR and SE functions. .

Products

- Aircraft Situation Display (ASD) functionality
- Monitor Alert (MA) functionality
- Prototype Automated Demand Resolution (ADR) functionality
- Prototype Strategy Evaluation (SE) functionality
- Prototype Automated Execution (AEX) functionality
- Prototype Dynamic Special Use Airspace (DSUA) functionality

H.2.2 Oceanic Air Traffic Automation (021-140)

Responsible Division: ARD-20
Contact Person: Jim McDaniel, 202/267-3534

Purpose

To increase oceanic air traffic capacity and efficiency by providing automation for oceanic airspace.

The current oceanic environment has no radar coverage. Navigation is handled using only aircraft on-board systems; air traffic operations are performed either manually or with limited automation. Air/ground communications are through a third party service provider via high frequency radios.

When fully developed, the automated oceanic air traffic management system will provide airspace structuring that will reduce controller workload and safely increase system capacity to help cope with the ever-increasing demand for transoceanic travel. This project will combine three oceanic RE&D projects: ADS, Oceanic Traffic Planning System (OTPS), and Oceanic Automation.

Research and development studies will identify new air traffic control procedures and the automation necessary to increase airspace user's operating efficiency. The studies will focus on airspace utilization, system development, and advanced functions.

The OTPS project will provide oceanic traffic managers with automated information gathering techniques and route development and analysis tools to provide better fuel economies and time efficiencies to users in oceanic airspace. Development efforts include the functions of generating flexible tracks to take advantage of favorable wind conditions, providing traffic managers with a traffic display system to graphically display aircraft positions over the oceanic airspace,. and a track advisory function that interactively provides airlines, before their oceanic gateway entry, with gateway loading delays for air carriers, and reduces workload for controllers. Also, traffic management capabilities will be developed for automating the transfer traffic management information between international ATC facilities and aeronautical operation controls (AOCs). All of these oceanic traffic management functions will eventually be integrated with the domestic enhanced traffic management system (ETMS).

Another project is developing ground-based systems using ADS technology and satellite communications links. Development efforts will upgrade oceanic display and planning system (ODAPS) technology with new displays and controller input-output devices. Future developmental efforts will include electronic ATC clearance delivery to aircraft, enhanced conflict detection and resolution, and electronic flight data displays.

Standards, requirements, and procedures will be thoroughly tested to validate system performance and capabilities prior to any production decision. An initial testing capability exists at the Oceanic Development Facility (ODF) and it will be enhanced to conduct the full-range testing that will be required, such as using real satellites, real ground/earth stations, and aircraft cockpits to identify total system performance and highlight areas needing improvements.

Program Milestones

In FY93, a Separation Improvement Program Plan was developed and analysis was completed for a U.S.-led initiative to reduce oceanic separation standards. The ground/ground data communications function that lays the groundwork for full two-way data link communications between pilots and controllers was completed. An interim situation display was installed at ODF.

In 1995, efforts will continue toward coordinating industry standards in the areas of avionics characteristics and minimum operational performance standards. Engineering trials in the Atlantic and Pacific will be completed. These trials will be used for developing requirements and standards for ADS functions, dynamic rerouting, track generation, and other oceanic automation features.

Also in 1995, an ODAPS central processor replacement effort and an oceanic electronic flight data display computer human interface study will be completed. These studies will be used in 1996 with a study on ADS reporting rates to support the transition of ODAPS to an advanced oceanic automation system.

Electronic flight data and a conflict detection/resolution capability will be delivered to the ODF in 1997. Development will continue on display enhancements for integration into the interim situation display hardware. The ODF will be completed in 1995 when the cockpit interface to the end-to-end simulation capability is installed.

In 1996 through 1998, studies for advanced functions will be completed, the air traffic management project will expand the South Pacific strategic planning system concept to incorporate foreign traffic management systems. Also during that time, a final software version of the electronic flight strips and conflict detection/resolution capability will be completed to provide controllers with aircraft separation recommendations.

Products

- Ground/ground data communications capability
- Oceanic controller situation display
- Oceanic traffic planning and management functionality into domestic TMS
- Oceanic airspace coordination function
- Automated data interchange/transfer to and from foreign Civil Aeronautics Administrations
- Two-way communications between aircrews and oceanic controllers
- Enhanced conflict detection/resolution capability
- Next generation flight data processor
- Track advisory capability for Anchorage and New York oceanic centers

H.2.3 Terminal ATC Automation (TATCA) (021-180)

Responsible Division: ARD-40
Contact Person: Chuck Friesenbahn, 202/267-3808

Purpose

To develop automation aids to assist air traffic controllers and supervisors by providing advisories designed to optimize the flow of traffic in the terminal area and to facilitate the early implementation of these aids at busy airports.

The TATCA program consists of three projects to assist air traffic controllers. These projects are: the Converging Runway Display Aid (CRDA), the Center-TRACON Automation System (CTAS) and the Controller Automation Spacing Aid (CASA). CRDA provides geometric spacing aids for aircraft by means of software changes within existing ARTS terminal radar processors. A Federal Aviation Order (7110.110) governing dependent converging instrument approaches utilizing CRDA was signed November 30, 1992.

The CTAS project is now in full-scale field development and consists of the following tools: a comprehensive traffic planning and scheduling tool known as the Traffic Management Advisor (TMA) for the Air Route Traffic Control Center (ARTCC), a Descent Advisor (DA) for en route controllers, a turn and speed advisor for terminal controllers known as the Final Approach Spacing Tool (FAST) and an ascent trajectory synthesis tool for departing aircraft known as Expedite Departure Path (EDP).

Longer term TATCA activities focus on fully developed terminal automation techniques integrated with other ATC and cockpit automation capabilities of the Advanced Automation System (AAS) and other ATC and cockpit automation capabilities.

Program Milestones

TMA is currently being evaluated and demonstrated in the Denver ARTCC. Further field evaluation for TMA and FAST will take place at the Dallas/Fort Worth Center in FY93 and continue in 1994. Laboratory development of DA and EDP is continuing.

Products

Major CRDA milestones include:

- Begin national implementation 07/92

Major TMA milestones include:

- Field Concept Development and Evaluation 08/92
- Limited Deployment 10/94

FAST milestones include:

- Fast Functionality in FDADS 08/92
- Field Concept Development/Evaluation 05/93
- Begin Limited Deployment 04/96

DA milestones include:

- Develop Prototype Software 07/93
- Deploy DA in ISSS 04/95
- Develop DA in ACCC 04/98

EDP milestones include:

- Field Concept Development 04/95
- Begin Limited Deployment 04/97

CASA milestones include:

- Begin Limited Deployment 06/95

TATCA/AAS milestones include:

- Modification to the System Level Specification for the AAS 06/94
- Integrated TATCA with ACCC 06/94

H.2.4 Airport Surface Traffic Automation (ASTA) (021-190)

Responsible Division: ARD-50
Contact Person: John Heurtley, 202/646-5566

Purpose

To provide controllers with automatically generated alerts and cautions in all weather conditions and data TAGS to identify all aircraft and special vehicles on the airport movement area.

To develop airport surface surveillance, communications, and automation techniques that will provide an effective runway incursion prevention capability by using ground sensor primary radar Airport Surface Detection Equipment (ASDE-3), Automated Radar Terminal System (ARTS), Differential-Corrected Global Positioning System (DGPS), and Airport Movement Area Safety System (AMASS).

The ASTA program has historically consisted of two major elements: surface safety automation and surface traffic automation. The surface safety automation element is composed of the Airport Movement Area Safety System (AMASS) and the Runway Status Light System (RSLS). ASDE-3/AMASS provides automatically generated alerts and cautions of impending runway incursion situations directly to the controllers. AMASS is currently in acquisition, but additional research and development of staged improvements using sensors other than the ASDE-3 may be undertaken. The RSLS automatically operates lights at all runway entranceways and at the take-off hold position to directly indicate to the pilots that the runway is "hot," i.e., there is an airplane on close final approach or on departure. RSLS is presently being implemented at Boston Logan International Airport for operational suitability assessment from 1995 to 1996.

The surface traffic automation element will develop means to provide identification TAGS for all aircraft and vehicles on the airport movement area and all aircraft in ramp and limited gate areas. The TAGS are to be displayed on the ASDE-3 display. Also to be developed is a surface traffic planner that will be integrated in an optimal manner with TATCA automation for aircraft on approach and DSP automation for aircraft on departure. Surface traffic planning automation will assist the tower and ramp controllers in reducing taxi-out delays and thereby increase airport capacity.

The surface traffic automation part of ASTA consists of three subsystems. Commercial Air Carrier Identification combines Differential Global Positioning System

(DGPS) and other surface sensors with a surveillance data link to provide positive identification of all commercial air carriers. General Aviation/Vehicles Identification will likely use a form of positioning TAG determination based on the MODE-A 4096 code. Traffic Planner/Conformance Monitor will process track and flight data to provide the controller with automated traffic plan assistance in all weather conditions and will also provide taxi route conformance monitoring.

All airports that are slated to receive ASDE-3/AMASS equipment under the F&E program will also receive TAGS and the ASTA Traffic Planner. For those airports not equipped with ASDE-3/AMASS, other airport surface sensors, such as the DGPS surveillance data link coupled with a "low-cost" ASDE may be used.

Program Milestones

The ASTA project was started in FY89 to reduce the risk of runway incursions and improve airport capacity through increased efficiency of aircraft surface movements and better departure traffic management. In FY90, alternative capabilities for reducing runway incursions were identified. In FY93, contracts were awarded to demonstrate alternative technologies to prevent runway incursions, the third AMASS was established at Boston Logan International Airport to provide an ASTA DGPS testbed, and the RSLS was successfully demonstrated to industry at Boston Logan.

In 1994, a Request For Proposal (RFP) for limited competitor selection will be issued, and contract award will be June 1995. Full Scale Development (FSD) for the commercial aircraft TAGS subsystem will be May 1996, with first Operational Readiness Date (ORD) June 1998. FSD for general aviation/vehicle TAGS will be September 1996, with first ORD March 1999. The ASTA Traffic Planner FSD (first implementable package) is planned for March 1997, with first ORD July 1999.

H.2.5 Tower Integrated Display System (TIDS) (021-210)

Responsible Division: ARD-100
Contact Person: Bob Sheftel, 202/267-7645

Purpose

To consolidate the displays and instrumentation used in towers for airport environmental data and control equipment, thus facilitating the installation of future tower systems such as TCCC.

This project is divided into two phases. In Phase I, a market survey will be conducted to determine the availability of systems meeting the requirements of Air Traffic with a minimal development effort. The results of the market survey will be used to determine an initial set of TIDS requirements and an appropriate acquisition strategy so as to field TIDS in the near term. These requirements will be developed through a team effort within the FAA. Documentation for transition to a Facilities and Equipment (F&E) program will be developed, including the program documents and production specifications to support implementation of the initial TIDS.

Phase II will be initiated in parallel with Phase I. Phase II will assess and integrate TIDS enhancements packages to meet the full range of Air Traffic's TIDS requirements.

Program Milestones

TIDS has been in hold status since mid-FY93 pending a decision on the deployment of TCCC. In FY94, a specification and statement of work for an initial TIDS contract was completed in preparation for release of an RFP. Upon receipt of a decision to proceed, the specification and statement of work will be revised and contracting activity will resume. Integrated Operational Test and Evaluation activities will be completed using the TIDS prototype, and this will lead to a potential initial TIDS deployment. TIDS enhancement activities will continue, leading to a potential first enhancement package. Other enhancement packages will continue to be investigated.

Products

- Initial TIDS requirements
- Prototype TIDS
- TIDS enhancement requirements
- TIDS enhancement prototype

H.2.6 Multiple Runway Procedures Development (021-220)

Responsible Division: ARD-100
Contact Person: Gene Wong, 202/267-3475

Purpose

To develop ATC concepts and procedures to reduce airport delays by more fully utilizing the capacity of multiple runway configurations during Instrument Meteorological Conditions (IMC).

Air traffic procedures and flight standards criteria for simultaneous dual, triple, and quadruple Instrument Flight Rules (IFR) parallel approaches will be developed and validated. Requirements and techniques for improved surveillance, navigation, and ATC display capabilities will be developed to support these procedures.

Studies sponsored by the FAA and the aviation industry have identified technical and operational concepts with the potential to reduce airport arrival delays by better utilizing multiple runway configurations in IMC. These concepts include the use of improved and current monitoring systems for conducting simultaneous approaches to dual, triple, and quadruple parallel runways. Improved monitoring technology includes precision runway monitor (PRM) systems, as well as high resolution ATC displays with controller alert aid and Airport Surveillance Radar-9 (ASR-9) or Mode S. Such displays are referred to as the Final Monitor Aid (FMA). Promising concepts will be validated through ATC simulations and, in some cases, full-scale demonstrations at airports.

Multiple IFR parallel approach procedures for Dallas/Ft. Worth Airport, which has planned the addition of third and fourth parallel runways, were developed in order to gain technical and operational insights, as well as to help expedite the implementation of such procedures. This procedure was site specific and was developed based on the use of current ARTS displays and ASR-9. This was followed by the development of national standards for triple and quadruple IFR parallel approaches based on the current ARTS display and ASR-9 capabilities.

The FAA has completed demonstrations of electronically scanned and "back-to-back" antenna PRM technologies resulting in the acceptance of simultaneous approaches to parallel runways spaced as closely as 3,400 feet. This project will conduct additional analyses and simulations to investigate the combined use of improved data rate PRM technology with highly accurate navigation/landing systems, such as satellite navigation system, microwave landing system, and state-of-the-art autopilot to further reduce the spacing standards of parallel runways. The results of these studies for dual parallel runways will also provide the basis for the analysis of spacing standards for closely spaced triple parallel runways. The final phase of the multiple runway procedures development will focus on quadruple parallel runways.

Program Milestones

In FY91, simulation evaluation of simultaneous IFR approaches to triple parallel runways spaced 5,000 feet apart, using ASR and ARTS displays, was completed. Simulations of triple parallel IFR approaches to runways spaced 4,300 feet apart using ASR-9 and high-resolution color displays with automated alerts were performed in FY92. Additional simulations to investigate the feasibility of using high-resolution color displays with automated alerts and ASR-9 to reduce dual and triple parallel runway spacing standards to 4,000 feet were conducted in FY92. Simulations of dual and triple runways spaced 3,000 feet apart, using the PRM system, were conducted in FY92. Simulation evaluation of the use of offset localizer and PRM to reduce the dual parallel runway standard to 3,000 feet were initiated in FY92.

In FY93, the FAA approved national standards for triple simultaneous parallel approaches. Such approaches may be conducted to runways spaced a minimum of 5,000 feet apart using current surveillance equipment (ARTS controller displays and ASR-9 radar sensors), provided that the airport elevation is less than 1,000 feet above sea level. At higher elevations, or for runway spacings between 4,300 and 5,000 feet, triple simultaneous approaches may be conducted if the monitor controller uses an FMA display.

The thinner air at higher elevations leads to higher ground speeds for aircraft on final approach. These higher ground speeds in turn mean that in the event of a blunder on final approach, the blundering aircraft can cross the distance between the parallel runways more quickly. Simulations of the new Denver International Airport (DEN) (elevation 5,200 feet) conducted at the FAA Technical Center confirmed this effect. However, these simulations also confirmed the benefit of using FMA displays, which enable the controller to detect a blunder much sooner than the current ARTS displays. FMAs have been installed at DEN, and the first triple simultaneous instrument approaches in the world will be conducted when the new airport opens in FY94.

Simulations to be conducted at the FAA Technical Center in FY94 will help to establish national standards for dual simultaneous approaches to runways as close as 3,000 feet. Such operations would be beneficial at New York's John F. Kennedy International Airport (JFK), where Runways 22R and 22L are 3,000 feet apart, and at Philadelphia International Airport (PHL), where a new commuter runway is planned to be built at that spacing.

Products

- Recommendation on ATC procedures
- Simulation analysis of ATC procedures
- Flight procedures and system requirements for simultaneous IFR approaches to triple and quadruple parallel runways using existing and improved runway monitoring systems
- Technical reports on simulation results and risk analyses

H.2.7 Wake-Vortex Separation Standards Reduction (021-230)

Responsible Division: ARD-200
Contact Person: Cliff Hay, 202/267-3021

Purpose

To safely reduce separation standards by understanding wake-vortex strength, duration, and transport characteristics, especially the effects of vortices in the terminal environment. Reduction in separation standards will enhance airspace use, increase airport capacity, and decrease delays in instrument meteorological conditions (IMC).

Data from tower fly-by tests will be combined with new data to determine actual traffic spacing being used under visual flight rules (VFR) conditions. Vortex strength, decay, and transport characteristics, as well as the meteorological conditions that affect these characteristics, will be examined at selected airports. Flight test simulations will be designed and conducted to determine if reducing the separation standards currently being used under IFR conditions is feasible. Closely spaced parallel and converging runways and departure sequencing will also be studied through simulation. Existing aircraft weight classifications will be reviewed to determine whether the weight classifications and corresponding separations can be modified to improve single runway operations.

Program Milestones

In FY93, appropriate high traffic airports were selected for data collection for capacity analyses. Data will be analyzed in FY94 to develop new parallel runway separation criteria for FAA approval in FY95.

Work will continue on a joint effort with NASA to develop models and simulation techniques that characterize wake-vortex hazards. Flight tests will be conducted to validate the models and simulations. In parallel with these models and simulations, work will continue on developing algorithms to integrate sensor inputs and provide the information to ATC automation systems by the year 2000.

Products

- Feasibility report on reducing separation standards in the terminal area
- Recommendations on aircraft weight classifications
- Separation algorithms to TATCA based on leading/following aircraft types

H.2.8 Traffic Alert and Collision Avoidance System (TCAS) (022-110)

Responsible Division: ARD-200
Contact Person: Tom Williamson, 202/267-8465

Purpose

To develop, demonstrate, and assist in implementing an independent airborne collision avoidance capability to increase safety in the National Airspace System by reducing the potential for midair collisions and increase capacity by using the improved cockpit display capability for simultaneous approaches to parallel runways and pilot maintained in-trail spacing.

There are three TCAS versions, each with successively increasing capability. TCAS I generates traffic advisories to assist pilots in locating potential midair collision threats. TCAS I is under evaluation through a Limited Implementation Program (LIP) on several types of in-service commuter aircraft. This program will provide operational and performance data on commercial TCAS I equipment in actual service.

TCAS II equipment includes a Mode S transponder and is intended for installation in transport category and high performance general aviation aircraft. It provides traffic advisories and also compute vertical-plane resolution advisories that indicate the direction the aircraft should maneuver to avoid collisions. Resolution advisories between two aircraft are coordinated between aircraft using the integral Mode S transponder. TCAS II development and operational implementation have been completed. Federal Aviation Regulations require that all aircraft with more than 30 passenger seats operating in U.S. airspace be equipped with TCAS II by December 30, 1993.

TCAS IV equipment, intended for installation in transport category aircraft, is designed to generate traffic advisories and resolution advisories in both the horizontal and vertical planes. Maneuvers will be coordinated between similarly equipped aircraft. The FAA is supporting minimum operational performance standards (MOPS) development for TCAS IV by a RTCA special committee. The FAA has developed a plan to complete the remaining development and test efforts and evaluate the TCAS IV system on airline aircraft in a LIP.

Program Milestones

All 10 to 30 seat turbine-powered commuter aircraft must be equipped with TCAS I by February 9, 1995 in accordance with Federal Aviation Regulations. That same year, the FAA will continue a multi-year TCAS I transition program to assist aircraft operators with TCAS I implementation.

As mentioned above, all commercial turbine-powered aircraft with more than 30 passenger seats are required to be equipped with TCAS II in accordance with Federal Aviation Regulations. In 1995, the FAA will continue to work with the aviation community to resolve technical and operational issues associated with TCAS II implementation. Engineering support to develop logic modifications to reduce unnecessary alert rates will continue.

A LIP will be conducted to determine the certification and operational requirements for TCAS IV.

Products

- Reports on TCAS I avionics evaluation to provide guidance for TCAS I certification and operation
- Reports on TCAS II installation, certification, and operation on air carrier aircraft
- TCAS II transition program report documenting TCAS II implementation program results and required modifications
- TCAS II requirements document for TCAS II certification in transport category aircraft
- ICAO standards and recommended practices for international certification and operational approval of TCAS II
- RTCA MOPS for required performance of TCAS IV under standard operating conditions
- Study assessing the safety characteristics of TCAS IV
- Report on TCAS IV installation, certification, and operation in air carrier aircraft

H.2.9 Vertical Flight Program (022-140)

Responsible Division: ARD-30
Contact Person: Richard A. Weiss, 202/267-8759

Purpose

To improve the safety and efficiency of vertical flight (VF) operations and increase NAS capacity through RE&D into air traffic rules and operational procedures, heliport/vertiport design and planning, aircraft/aircrew certification training, and applications of emerging technology.

Program Milestones

The Rotorcraft Master Plan (RMP) envisions advanced VF technologies providing scheduled short-haul passenger and cargo service for up to 10 percent of projected domestic air travel. To accomplish this expanded use of vertical flight, the FAA is responsible for developing the appropriate infrastructure and regulations in parallel with industry's actions and commitment to develop and operate market-responsive aircraft.

The VF program is being executed through many concurrent projects and activities, which are divided into three technical sub-program areas: Air Infrastructure, Ground Infrastructure, and Aircraft/Aircrew.

The Air Infrastructure sub-program will provide RE&D to enable safe, reliable, all-weather operations for VF passenger and cargo aircraft. The research results will include: developing non-precision and precision GPS terminal instrument approach and departure procedures; more compatible IFR approach and departure angles; improvements in low altitude navigation and air traffic control services using GPS, data link and SATCOM technologies; VF air route design; and noise abatement procedures.

Ground Infrastructure research will address heliport and vertiport design and planning issues, including the terminal area facilities and ground-based support systems that will be needed to implement safe, all-weather, 24-hour flight operations. Developing obstacle avoidance capabilities is a critical design-related effort. Research will include applying lessons learned from detailed accident and rotorcraft operations analyses. Simulations will be used extensively to collect data, analyze scenarios, and provide training to facilitate safe operations.

Aircraft/Aircrew research will develop minimum performance criteria for visual scenes and motion-base simulators; evaluate state-of-the-art flight performance for cockpit design technology; develop improved training techniques employing expert decision making, and develop crew and aircraft performance standards for determination of display and control integration requirements. Research will also be conducted in support of the FAA's responsibilities to certificate both conventional and advanced technology VF aircraft.

Products

- Helicopter non-precision and precision GPS approach terminal instrument procedures criteria
- ATC route standards, procedures and models
- Vertiport/heliport design standards
- Improved VF noise planning tools
- VF noise abatement procedures
- Rotorcraft simulator standards
- VF aircrew training and certification requirements
- Cost/benefit assessments for deploying advanced VF technologies

Schedule

- Produced audio visual training aids and workbooks to assist in training in expert decision making techniques — FY94
- Published delay reduction analysis for a Northeast Corridor civil tiltrotor-based short-haul transportation system — FY94
- Delivered night vision enhancement device operations and training materials — FY95
- Publish advanced technology VF performance and demonstration guidelines — FY95
- Publish results of test and analysis of a variety of heliport and vertiport design parameters, including minimum required VFR airspace for curved approaches and departures, minimum parking and maneuvering areas, marking and lighting, and rotorwash protection requirements — FY96
- Conduct extensive VF noise data collection from operational profiles — FY96
- Publish Technical Report supporting certification requirements of VF aircraft display formats — FY96
- Publish national-level guidelines for joint industry and local government advanced technology VF demonstration program — FY96

- Develop low noise conversion corridor criteria for rotorcraft — FY97
- Publish terminal area IFR procedures for steep-angle approaches and departures — FY97
- Publish simulation-based analysis of pilot performance in an obstacle-rich environment, with results being used to evaluate necessary heliport and vertiport design criteria — FY97
- Publish advanced technology rotorcraft noise certification recommendations — FY98

H.2.10 Flight Operations and Air Traffic Management Integration (022-150)

Responsible Division: ARD-100
Contact Person: Bill Blake, 202/267-7264

Purpose

To develop the capability to integrate aircraft flight management systems (FMS) with ground-based air traffic management (ATM) automation via data link to increase airspace capacity and ensure more efficient flight operations along more flexible conflict-free route trajectories.

An important factor in ATM and FMS integration is developing automated communications between aircraft FMS and ground ATM computers. This will be accomplished by developing a set of flight operations and air traffic management integration (FTMI)-specific data link operational requirements. FTMI operational concepts will be developed and validated via simulation experiments coupled with aviation community-supported flight trials.

This project will establish the operational requirements for flight operations procedures and standards fully utilizing existing FMS capabilities in the near-term to enhance system capacity and flight efficiency in oceanic, en route, and terminal airspace. This analysis will lead to standards for nationwide FMS-guided terminal operations by analyzing requirements for FMS-guided curved approaches to and departures from selected airports.

A standard set of functional and operational requirements to support the next generation ATM-compatible FMS will be developed. This effort will integrate existing and planned capabilities of the ATM system and the FMS/flight deck.

In addition to enhanced ATM and FMS integration, this project will explore the benefits of including the aeronautical operation control (AOC) component of the fight operations system to the integrated ATM/FMS. The information exchanged between AOC and ATM could provide fuel savings, more efficient use of airspace, and reduce delays.

Program Milestones

In FY93, an analysis to support flight standards for developing FMS-guided curved approaches at Minneapolis-Saint Paul International Airport (MSP) was completed. Continued analyses to support development of flight standards and procedures for both FMS-guided approaches and departures at selected airports will be completed in FY95. Nationwide FMS-guided terminal operations standards are expected in FY97.

Simulation experiments involving route maneuvering in oceanic airspace to demonstrate FMS capabilities in improving flight efficiency in oceanic airspace will be conducted in FY94 and FY95. Flight trials will be conducted with commercial airlines to validate procedures generated as a result of these simulations. Analysis of simulation experiments and flight trials is expected to result in flight standards by the year 2000.

Efforts will continue in FY95 to develop a functional and operational requirements document for advanced FMS capabilities to ensure full integration of flight management and ATM operations.

Products

- Data to support flight operations procedures and standards for FMS-guided operations in terminal, domestic en route, and oceanic airspace and on the airport surface. Candidate ATM procedures to support FMS-ATM-AOC integration via data link
- Integrated FMS-ATM automation system operational concept document
- New FMS-ATM system capabilities document
- FMS-ATM automation interface requirements document
- FMS-ATM integration requirements document
- Revisions to two-way data link clearance data dictionary

H.2.11 Separation Standards (023-120)

Responsible Division: ARD-100
Contact Person: Carl Bowlen, 202/267-7047

Purpose

To provide quantitative guidance for domestic and international efforts to establish minimum safe horizontal and vertical separation standards.

Tests will be conducted to provide quantitative guidance based on statistical analysis to support decision-making to reduce vertical and horizontal (lateral and longitudinal) separation requirements. This activity consists of model development, data collection, data reduction, and analysis and includes: (1) the investigation of the effect on separation standards of imposing tighter required navigational performance specifications, (2) determination of the effect of tolerating mixtures in the total aircraft population of both old and new specifications, and (3) investigations of the potential for the safe improvement of separation requirements in a system with advanced future navigation, communications, and air traffic management systems. This effort will also help establish separation requirements based on Automatic Dependent Surveillance (ADS), Area Navigation (RNAV), and other developing technologies for supporting reduced permissible separation minima.

The oceanic horizontal separation standards program will analyze separation standards in the North Atlantic, West Atlantic, Central East Pacific, and North Pacific route systems. It will examine the impact of various system improvements on safe minimal lateral and longitudinal spacings for oceanic traffic. As oceanic control becomes increasingly flexible through improved communications and enhanced automation, this program will establish appropriate separation standards to improve system efficiency while maintaining and acceptable level of safety.

Onboard, time-based navigation capabilities and associated ATC procedures will be analyzed to determine the effects of changing from a distance to a time-based longitudinal separation standard.

The vertical separation program has determined the feasibility of reducing the vertical separation minimum between FL290 and FL410 from 2,000 to 1,000 feet, thus adding six additional flight levels in this altitude range. Efforts in this area are aimed at implementing RNAV initially in the North Atlantic and then the Pacific. Full implementation in NAS is scheduled for January 1998. This change will provide the ATC system with enhanced flexibility to accommodate user-preferred flight profiles and will lead to substantial savings in user fuel costs.

Program Milestones

In FY90, the ICAO guidance material for world-wide and regional reduction of the high-altitude vertical separation standard from 2,000 to 1,000 feet was finalized and approved.

In FY91 the national guidance material amending current Pacific track longitudinal separation standards was completed. This amendment resulted in application of a 10-minute separation minimum.

In FY93, agreement was reached for implementation of a reduced vertical separation minimum in NAS minimum navigation performance specification (MNPS) airspace with operational trials commencing January 1, 1997. Beginning in the spring of 1995, height-keeping performance will be evaluated to ensure compliance with published altimetry and altitude keeping performance.

In FY94-95, ICAO guidance material for separation standards in the horizontal plane will continue to be developed. The four major items are area navigation (RNAV), Required Navigation Performance (RNP), Automatic Dependent Surveillance (ADS), and General Guidance on Separation Standards for Airspace Planners. The goal is to complete RNAV guidance in 1994-1995. The RNP was requested by the ICAO Future Air Navigation Systems (FANS) committee and has implications for the world-wide use of global positioning system (GPS) and establishing separation standards. The RNP guidance material for en route of types was approved in 1993. The introduction of ADS will provide near real time surveillance and communications in many areas that presently depend on pilot reports over high frequency communications. A new methodology is being developed to provide quantitative guidance for establishing separation standards reflecting new technologies. These new technologies include ADS, satellite-based navigation, enhanced communications, and advances in the air traffic management system. This effort is expected to be completed in 1995-1996. The final major effort is the continued work on developing general guidance on separation standards for airspace planners. This effort is expected to be completed in FY96.

Products

Horizontal Separation Standards

- Reports on the feasibility of reduced horizontal separation in oceanic airspace

- Reports on simulation and test results for reduced horizontal oceanic separations
- Data packages for international coordination of horizontal oceanic separation standards
- Requirements for implementation of reduced horizontal oceanic separation standards

Vertical Separation Standards

- Data analysis and operational tests and evaluation of reduced vertical separation
- Support for rulemaking on vertical separation standards
- Input to ICAO documents
- Support for implementation of reduced vertical separation minimums in Pacific airspace
- Monitoring of height keeping performance with implementation of reduced vertical separation minimums in North Atlantic MNPS airspace

H.2.12 Aviation System Capacity Planning (024-110)

Responsible Division:	ASC-100/200
Contact Persons:	Jim McMahon, 202/267-7425 Nick Johnson, 202/267-9817

Purpose

To establish a forum, sponsored and supported by the FAA, in which airport management, local FAA, airline, commuter, and industry groups, and airport planning consultants work together to develop technically feasible alternatives for improving airport and airspace capacity and reducing delay.

Capacity design team studies have been established at various airports where the need for capacity improvement has been identified. The studies typically investigate application of new air traffic control procedures, navigation aids, system installations, airport development, and other prospective capacity improvements. Alternatives are then evaluated using state-of-the-art computer simulations. The simulations provide a measure of the potential benefits of these improvement alternatives in terms of hours of delay reduction and allow the FAA to refine modeling techniques while gaining operational benefits through assistance to the capacity design team studies.

Program Milestones

The *1993 Aviation System Capacity Plan* was produced, analyzing the benefits of new airport development, airspace changes, new technology, and progress in implementing improved air traffic control procedures to support airport, airspace, and procedures improvements. In addition, final reports for airport capacity design team studies at Albuquerque, Boston-Logan, Cleveland, Port Columbus, Eastern Virginia (Richmond, Norfolk, and Newport News/Williamsburg), Fort Lauderdale-Hollywood, Houston Intercontinental, Indianapolis, and Minneapolis-Saint Paul were issued. Airport capacity design team studies are underway at Dallas-Fort Worth, Las Vegas, and Portland. A terminal airspace study was completed for San Bernardino International Aiport. Airspace design teams for New York (Phase II), Jacksonville, Atlanta, and Miami/San Juan were completed in FY93 and final reports were issued in FY94.

In FY94, tactical initiatives will be underway for New York's LaGuardia Airport, Orlando International Airport, and Los Angeles International Airport. In addition, terminal airspace studies are underway for Philadelphia, Salt Lake City, and Tampa. A terminal airspace study is also planned for San Antonio. Regional design studies are planned for the San Francisco Bay Area, the Los Angeles Basin, and the New York Metropolitan Area. Airport capacity design team updates are underway for Seattle-Tacoma International Airport and Hartsfield Atlanta International Airport. .

From 1995 to 1998, simulations and flight demonstrations will be conducted to determine if the use of TCAS can be expanded to provide separation assistance.

Products

- Aviation System Capacity Plans
- Airport Capacity Design Team Reports
- Airspace Analysis Technical Reports
- Aviation Capacity Enhancement Action Plans
- Near- and long-term capacity enhancement report

H.2.13 National Simulation Capability (NSC) (025-110)

Responsible Division: AOR-20
Contact Person: Randall J. Stevens, 202/287-8504

Purpose

To establish the NSC to assess proposed subsystems, aviation procedures, airspace organization, and human factors in an integrated fashion to determine the definition of the 21st century NAS.

The NSC provides a means of analyzing and experimenting with alternative concepts for potential NAS development, as well as a capability for hands-on development of prototype configurations for future NAS integration. This enables improved assessment of new concepts, high-level system design, new technologies, system requirements, and potential problems and issues. Resulting requirements specifications for procuring NAS equipment will be more accurate, complete, and achievable.

Program Milestones

NSC began an active experimentation program in March 1992 at the Integration and Interaction Laboratory (I-Lab) at MITRE in Mclean, Virginia. During the balance of FY92, an active experimentation program was conducted, examining alternatives for interaction between traffic flow management and controller automation aids in the en route and terminal airspace. This initial phase of experiments concluded at the end of FY93. Also in FY93, a series of visualization exercises was conducted in support of initiatives from the FAA's Office of System Capacity and Requirements (ASC) to expand the use of TCAS as a separation assistance tool. Two exercises were run, one for closely-spaced parallel approaches into San Francisco International Airport and another to demonstrate an in-trail climb procedure proposed by United Air Lines. In FY94, a new series of experiments and visualization exercises will be conducted, examining integration issues associated with the time-phased implementation of AERA with CTAS, Traffic Flow Management (TFM), data link, and advanced weather products.

NSC began an active experimentation in November 1992 at the FAA Technical Center, using resources from both the Human Factors Laboratory and the Oceanic Development Facility. In FY93, experiments were run assessing alternative oceanic traffic control procedures needed for the introduction of new reduced vertical separation minimums in the North Atlantic. This work was completed in early FY94. Additionally in FY94, experimentation will be conducted exploring expansion of the in-trail climb procedure and in dynamic aircraft route planning in oceanic airspace.

Products

- Operational NSC experimentation capability to support assessments of interactions and inter-operations between ATC automation elements and aircraft and assessments of human performance in those systems
- Simulation results from alternative configurations of proposed future systems and procedures

H.2.14 Operational Traffic Flow Planning (025-120)

Responsible Division: AOR-200
Contact Person: Mark Salanski, 202/287-8526

Purpose

To provide near-term improvements in national level traffic flow management and influence the development of future traffic management systems.

The Operational Traffic Flow Planning (OTFP) program has the following goals:

- Quickly prototype decision support tools to supplement the expertise of the traffic flow management specialists of the Air Traffic Control System Command Center (ATCSCC).
- Develop strategies to resolve demand-capacity imbalances — using advanced operations research techniques and computer modeling.
- Analyze ATCSCC policies and procedures to ensure they benefit National Airspace System (NAS) users.
- Coordinate research efforts with other FAA programs to enhance nationwide operational traffic management.

The OTFP program is organized around a flexible plan for improving traffic flow management. It is designed so that developers can routinely make program adjustments based on changing operational concepts or advances in technologies. All project efforts are organized to quickly supplement the experience of national traffic management specialists and improve the selection of traffic flow management strategies.

OTFP research projects are organized into the following coordinated framework:

Strategy Development Tools

The OTFP system will generate optimal strategies for current or anticipated NAS conditions. It will provide the TFM specialist with one or more efficient strategies to consider. Models being developed for this program include the High Altitude Route System (HARS), Planned Arrival and Departure System (PADS), Knowledge-Based Flow Planning (SMARTFLOW), and Optimized Flow Planning (OPTIFLOW).

Demand Assessment Tools

Tools that access and analyze TFM information. Tools include Daily Decision Analysis System (DDAS) and the Flight Simulation Monitor (FSM). DDAS enables the ATCSCC to anticipate route and schedule changes made by the airlines and then examine associated capacity impacts. FSM enables air traffic managers to visualize the airlines' flight cancellations and substitutions.

Performance Measurement Tools

Tools that evaluate proposed flow management strategies and resolve demand/capacity imbalances in the NAS include the Daily Flow Simulation Model (FLOWSIM) and the NAS Simulation Model (NASSIM). FLOWSIM models traffic between all major U.S. airports up to 24 hours in advance. NASSIM analyzes the resource-limited throughput in the NAS and graphically presents this data.

Capacity Assessment Tools

These systems enable the ATCSCC to estimate NAS resource use and workload. The Critical Sector Detector (CSD), being developed by OTFP, determines which (if any) en route airspace sectors might reach controller workload saturation in the near future.

Policies and Procedures Research

These research efforts help traffic management specialists in the ATCSCC enact policies and procedures that affect all users of the NAS. The primary OTFP effort which could affect FAA policies and procedures research is the FAA-Airline Data Exchange (FADE). FADE seeks to evaluate how up-to-the-minute airline schedules affect traffic flow management decisions. OTFP researchers are assessing the viability of dynamically exchanging data with the airlines and assessing if updated demand information can influence air traffic management decision making, specifically in regards to ground delay programs.

TFM Decision Support Tool Testbed

OTFP tools are linked to a common data source to allow accurate modeling and analysis of the NAS or any of its components. The Continental U.S. National Airspace Data Access Tool (CONDAT) consolidates and translates data from several diverse and often inconsistent sources into a single standardized repository.

Program Milestones

In FY94, the HARS capabilities were expanded to include enhanced communications software for FAA/ airline interactive planning. Also accomplished in FY94: a demonstration/ evaluation of PADS was completed; the FLOWSIM field prototype was developed; the CONDAT prototype demonstration and testing was completed; the initial NASSIM prototype testbed was developed; development, demonstration, and testing were completed for the SMARTFLO field prototype; and the FSM, the ground delay program substitution visualizer, was implemented as a field prototype.

HARS - Field prototype development will continue in order to provide follow-on enhancements to enable full track generation and traffic optimization for high altitude traffic anywhere within the United States. It will also develop the integration necessary to provide interoperability with national and oceanic traffic management systems. In 1995, ADS and data link system interfaces will be developed to provide real-time communications between ATCSCC and the full range of airspace users. This effort will complete HARS development and the resulting technologies will migrate into OPTIFLOW.

PADS - This functional prototype, scheduled for ATCSCC testing in 1995, will provide a real-time ability to develop airport departure and arrival scheduling plans that optimize daily traffic flows for long-range flights between major city-pairs. The field prototype development and demonstration is planned for 1995-1996. Delivery of the PADS field prototype in 1996 will enable ATCSCC and traffic management units (TMUs) to interactively plan with commercial aviation dispatchers to develop optimized high altitude flight sequencing in conjunction with the HARS and OAS traffic models.

OPTIFLOW - Operations research for this model will be completed in 1995. The initial prototype testbed demonstration and ATCSCC evaluation will begin in 1995. The field prototype development will follow in 1996 with field prototype demonstration and evaluation planned for late 1996 and early 1997. Field prototype delivery is planned for 1997.

FLOWSIM - The integration of this model with other tools will be completed in 1995.

CONDAT - Development and integration of this model will continue through 1997.

NASSIM - Operations research for predicting and simulating detailed daily traffic and flow strategies will continue in 1995. This model will use and integrate many technologies and tools developed for other projects (HARS, PADS, FLOWSIM, and OPTIFLOW). The initial prototype demonstration and evaluation is planned for 1995. Follow-on field prototype development is planned for 1995-1996 with field prototype demonstration and evaluation scheduled to begin in 1997. Field prototype delivery to ATCSCC and TMUs is planned for late 1997.

SMARTFLO - Delivery of this model to ATCSCC is scheduled for 1995.

DDAS - Testbed prototype development for dynamic, digital data exchange of scheduling information between the ATCSCC and airline scheduling facilities will continue in 1995. Prototype demonstration and testing is scheduled for 1995. Integration with other OTFP projects will follow in 1995-1997.

FSM - Prototype development will be completed in 1995. ATCSCC analysis and integration will continue for planned fielding in 1995-1997.

Products

Demand Assessment Tools

- Daily Decision Analysis System (DDAS) for automation tools to quickly analyze airline schedule change impacts
- Ground Delay Program Substitution Visualizer (GSUBV) to demonstrate the TFM effects of airline substitution practices
- Flight Simulation Monitor (FSM) to examine in real time which airplanes are being moved in response to a ground delay program

Performance Assessment Tools

- Daily Flow Simulation Model (FLOWSIM) for fast-time national pacer airport traffic flow simulation
- NAS Simulation Model (NASSIM) for detailed NAS-wide traffic prediction and simulation

Strategy Development Tools

- High Altitude Route System (HARS) for optimized fuel-efficient jet routes
- Planned arrival and departure system (PADS) for developing optimal departure and arrival scheduling plans
- Knowledge-Based Flow Planning (SMARTFLO) for quick response flow advisories to expert systems
- Optimized Flow Planning (OPTIFLOW) for dynamic national traffic flow optimization

TFM Decision Support Tool Testbed

- Continental U.S. National Data Access Tool (CONDAT) to provide a common data source for all OTFP simulation and optimization efforts
- OTFP System to integrate functions of the individual project initiatives

Policies and Procedures Research

- FAA/Airline Data Exchange (FADE) to evaluate how up-to-the-minute airline schedules affect traffic flow management decisions

H.2.15 Air Traffic Models and Evaluation Tools (025-130)

Responsible Division: AOR-200
Contact Person: Steve Bradford, 202/287-8519

Purpose

To produce modeling and analytic tools to support operational improvements, airspace and airport design, environmental analysis, investment decision-making, and ATC system design analysis.

The tools developed by this project will provide ATC with the ability to rapidly plan, evaluate, and update operational changes to accommodate the more dynamic airport/airspace environment. These models will respond to the dynamic changes resulting from satellite navigation and increased ATC and cockpit automation. This program will emphasize improvements to existing models and new model development. Modeling products will be improved to make them simpler, faster, more effective, and more widely used and accepted.

Development will focus on integrated airport and airspace modeling. Previously developed models, such as the National Airspace System Performance Analysis Capability (NASPAC) and SIMMOD, will be made easier, faster, and more flexible to use. The Sector Design Analysis Tool (SDAT) is used in redesigning en route airspace to increase capacity and balance controller workload. SDAT derivatives are the terminal airspace sector design analysis tool (T-SDAT) and the regional airspace sector design analysis tool (R-SDAT). These will provide new capabilities for evaluating terminal and multi-center en route airspace design. Another analytical tool, the critical sector detector (CSD), will be developed to determine when airspace sectors will reach critical traffic density levels based on controller workload limits.

Program Milestones

In FY94, SIMMOD capabilities were established in an ARTCC, a TRACON, and an FAA regional office. Also, new SIMMOD logic is being developed to increase simulated traffic dynamic control and account for en route system dislocations. In 1995, SIMMOD capabilities will be established at additional FAA regions and en route centers. In 1996, a new version (SIMMOD Version 3) will be released to accommodate future airspace requirements for user-preferred direct routing.

In FY94, R-SDAT was developed. R-SDAT implementation is expected in 1995. T-SDAT testing will be conducted in 1995, with completion/implementation scheduled for 1997. Work will continue in 1995 on CSD development with completion/implementation scheduled for 1996.

In 1995, work will continue on developing a user-friendly workstation production version of NASPAC. The current version of NASPAC is a prototype developed by the MITRE Corporation that considers various performance measures for determining NAS-wide impacts from proposed system improvements. The production model will permit analysts to conduct studies more easily and quickly, and will provide more sensitivity to proposed changes in the overall airspace system design. In 1995, an initial NASPAC production model will be released. NASPAC testing will be conducted at the FAA Technical Center through 1996, with implementation expected in 1997.

Products

- Enhanced SIMMOD airport and airspace simulation model
- SIMMOD capability installed in ARTCCs, TRACONs, and FAA regional offices
- NASPAC U.S. airspace simulation production model
- SDAT, T-SDAT, and R-SDAT
- Critical sector detector (CSD)

H.2.16 Airway Facilities Future Technologies (026-110)

Responsible Division: ANS-300
Contact Person: Brenda Boone, 202/267-7313

Purpose

To develop the concept of operations, methods, policies, standards, organizational structures, and functions, validate them in a near-operational testbed environment, and prepare an orderly transition strategy to achieve the new Airway Facilities (AF) infrastructure needed to support the future National Airspace System (NAS). This will be accomplished through the development and use of simulation models and distributed and dedicated test facilities for assessing alternative operational and support concepts and methodologies.

The traditional AF role is changing dramatically as a result of new technology, a changing work force, and increasing levels of automated management of AF systems. The AF RE&D Plan is intended to focus individual projects, activities, and related applied research toward the common goal of realizing acquisition readiness for the AF infrastructure by the year 2000. The plan will specify the guidelines for determining the AF operational, organizational, functional, and technological baselines as well as analyzing their mutual interdependencies. The plan will also specify a program implementation process to ensure that RE&D in each of the areas is integrated and that the products lead to an integrated overall system to meet AF's future needs.

Models will be developed through rapid prototyping to evaluate promising operational concepts. Proposed procedures and operational concepts will be tested in simulated operational environments and scenarios. Alternative organizational structures will be developed and modeled for assessment and refinement. Evaluation tools will be provided to measure the correlation among operational concepts, organizational structures, functional capabilities, and technological capabilities.

This project will develop a testbed to investigate various scenarios associated with new technologies such as remote maintenance monitoring, the Operational Control Center, and AF interfaces with satellite systems. Expert diagnostic, predictive, and resolution tools (EDPRTs) will be developed to support preventative maintenance and to help isolate and solve equipment problems. The testbeds will be used to develop requirements and design approaches for the EDPRT tools and to investigate their use in simulated operational environments. Applications for an intelligent tutoring system (ITS) will be identified to provide additional interactive tools to increase AF productivity. These tools will be fully integrated with the EDPRTs.

By defining and developing alternative concepts of operations and then testing them in a near-operational environment using models, tools, and specialized tests, including actual systems and equipment, this project will achieve a validated operations and support concept. This validated concept will enable the project to develop an orderly transition strategy to move AF incrementally from today's traditional approach to an integrated, centralized AF infrastructure fully supportive of the NAS.

Program Milestones

In FY94, a technology assessment to identify key technologies applicable to AF operations was completed. In 1995, work will continue on developing the AF testbed. In 1996, testbed requirements will be complete, leading to an Operational Control Center prototype and GPS software interface in 1998. Analysis results should be available in 1997 and 1998 for developing policies, procedures, and standards.

In 1995, work on integrated modeling tools will be initiated to identify organizational alternatives and to simulate future AF system responsibility/functions in the NAS. These simulation models should be completed in 1996. Work will begin on organizational structure analysis tools in 1996 with completion planned for 1997. The models and tools will be used in 1996-1997 to develop, evaluate, and validate AF strategies, concepts, and methodologies for modernization within the NAS. The models will also be used to measure performance for allocating procedures and technologies used in systems management. Promising concepts and methodologies will be evaluated. The concepts and methodologies will undergo final validation in 1998 via field testing at selected locations. AF operational standards will then be developed.

Development will begin on the ITS and the EDPRTs in 1996. Prototypes will be completed in 1998 with operational systems available in 1999. Additional ITS/EDPRT development needs will be identified as new technology becomes available.

Products

- AF research program plan
- AF system testbed
- Expert diagnostic, predictive, and resolution tools
- Intelligent tutoring systems
- Validated concept of operations, methods, policies, standards, organizational structures, and functions
- AF transition strategy
- Integrated management information system performance requirements

H.2.17 Terminal Radar (ASR) Replacement Program

Responsible Division: ANR-200
Contact Person: Gerald Taylor, 202/606-4622

Purpose

To provide economical radar service at airports with air traffic densities high enough to justify the service and upgrade the highest density airports with the latest state-of-the-art equipment.

ASR-4/5/6 radars need to be replaced because of the decreasing availability of spare parts and the high-maintenance workload. Furthermore, repair parts for the ASR-4/5/6 radars are in short supply. A total of 96 ASR-4/5/6 radars are being replaced. Of these, 40 ASR-4/5/6 sites are being upgraded to ASR-9's, 40 ASR-4/5/6's are being upgraded to ASR-8's, and 16 ASR-4/5/6's are being upgraded to ASR-7's, a procedure called "leapfrogging."

Program Milestones

The first ASR-9 Operational Readiness Demonstration (ORD) was in FY90 and the first leapfrog ORD was in FY91. The last leapfrog ORD is scheduled for FY96, and the last ASR-9 ORD is planned for FY96.

Products

- Procure 134 radars
- Replace 96 radars
- Leapfrog 56 radars

H.2.18 Los Angeles Basin Consolidation

Responsible Division: ANS-300
Contact Persons: Jonathan Dorfman, 202/267-8680
John McCartney, 310/297-8680

Purpose

To consolidate five Los Angeles Basin Terminal Radar Approach Control Facilities (TRACONs) to be known as the Southern California TRACON. This new facility will enhance traffic management in Southern California and allow more efficient use of the airspace.

The Los Angeles Basin is created by the Pacific Ocean and the San Rafael, Sierra Madre, Techachapi, San Gabriel, San Bernardino, San Jacinto, and Santa Ana Mountain ranges. The basin area is approximately 75 miles wide and 100 miles long. The major portion of this airspace below 10,000 feet is currently controlled by TRACON facilities located at Los Angeles, Burbank, El Toro (coast), Ontario, and San Diego. These five TRACON facilities provide instrument flight rule services for 29 airports within their respective areas of jurisdiction. This includes eight major air carrier airports and five military airfields. Instrument operations in Southern California have increased greatly over the last two years. Forecasts call for well over 3,000,000 operations by the year 2000.

Products

This consolidation will enhance safety, improve airspace utilization, and provide an IFR air traffic control system approach for the major hub and satellite reliever airports in Southern California.

- Start site adaptation 01/90
- Building contract award (completed) 09/91
- Building occupancy date 02/93
- Los Angeles TRACON consolidated 02/94
- Coast TRACON consolidated 05/94
- Burbank TRACON consolidated 10/94
- Ontario TRACON consolidated 04/95
- San Diego TRACON consolidated 09/95
- Project completed 02/96

H.2.19 Traffic Management System (TMS)

Responsible Division: ANA-600
Contact Person: William L. Umbaugh, 202/287-2708

Purpose

To upgrade the present flow control system into an integrated Traffic Management System (TMS) which operates at the national level through the Air Traffic Control System Command Center (ATCSCC) and the local level through traffic management units (TMUs).

The upgrading of the traffic management system is designed to improve air traffic system efficiency, minimize delays, expand services, and be more responsive to user requirements. The TMS functions include various flow management programs with integrated metering functions such as the Departure Sequencing Program (DSP), En route Spacing Program (ESP), and the Arrival Sequencing Program (ASP) and Enhanced TMS (ETMS) functions such as the Aircraft Situation Display (ASD) and Monitor Alert (MA).

Program Milestones

Phase II has provided the Enhanced Traffic Management System, which is a computer network that implements the aircraft situation display (ASD) and monitor alert (MA) functions developed by the Advanced Traffic Management System (ATMS) research and development program, for the Air Traffic Control System Command Center (ATCSCC), all Air Route Traffic Control Centers (ARTCCs), and several Terminal Radar Approach Control Centers (TRACONs). New computer systems with color graphics workstations have also been provided to the ATCSCC, TMUs, and the FAA Technical Center, which interface with the Traffic Management Computer Complex (TMCC), the host computers, and the ETMS computers to provide enhanced information displays and near real-time flight data. The Arrival Sequencing Program (ASP) and En Route Spacing Program (ESP) Package 1 metering enhancements to the host computers have also been provided.

Follow-on activities to Phase II will include providing automation equipment to non-en route facilities, relocating the ETMS computers from the development location to an FAA facility, providing an enhanced high data rate interface between the Host and ETMS computers, integrating DSP into the TMS and providing meter list display capabilities for the ARTCCs. Other activities will include implementing ATMS functions on the ETMS, providing TMS hardware and software in the Advanced Automation System time frame until the next generation TMS becomes operational, and improving traffic management performance analysis capabilities by developing standards, procedures, and tools to facilitate the accurate reporting, collection, and analysis of NAS data.

Products

- The TMS computer complex is located at the FAA Technical Center. ETMS computers are currently located at the John A. Volpe National Transportation Systems Center, Cambridge, Massachusetts.
- Computer program suitable for adaptation and use at 20 domestic ARTCCs and selected TRACONs.

H.2.20 LORAN-C Systems

Responsible Division: ANN-300
Contact Person: Charles B. Ochoa, 202/267-6601

Purpose

To conduct necessary procurement and implementation projects to meet FAA responsibilities for the use of LORAN-C in the NAS.

LORAN-C is the government's navigation aid for coastal areas of the United States, including southwestern Alaska. Signal coverage was increased in 1991 over the mid-continent area and now all 48 contiguous states have LORAN-C service. Low-cost avionics have made LORAN-C an attractive area navigation aid for general aviation; it has been approved for en route and non-precision approach use under instrument conditions. One goal remains: to bring LORAN-C into maximum use in the NAS as a supplemental aid by completion of the installation of signal monitors to support non-precision approaches throughout the NAS. The signal monitors will provide the seasonal time difference correction information required to accurately perform a non-precision approach.

Program Milestones

Two new LORAN-C chains of stations were completed in the U.S. mid-continent in April 1991. LORAN-C monitor units consist of two parts: monitors and interface electronics to VOR equipment. Signal monitors were installed at 196 sites. Installation will be completed in 1994 when interface electronics are placed in the host facilities.

Products

- LORAN-C Signal Monitor System
- LORAN-C mid-continent transmitters

H.2.21 Automatic Dependent Surveillance (ADS)

Responsible Division: ARD-30
Contact Person: Jim McDaniel, 202/267-9870

Purpose

To support the development and implementation of an Automatic Dependent Surveillance (ADS) function to improve safety and provide economic benefits to users of oceanic airspace, as well as to aid oceanic controllers in effectively controlling oceanic airspace, with evolutionary applications to domestic airspace.

The ADS function will provide for improvements in tactical and strategic control of aircraft. Automated processing and analysis of position reports will result in nearly real-time monitoring of aircraft movement. The capability of ADS to provide timely and high-integrity aircraft position data via a satellite air/ground link will permit possible reduction in separation standards, as well as increase accommodation of user-preferred routes and trajectories.

The program will be developed in conjunction with the Oceanic Data Link (ODL) capability, which will add two way digital data communications for air traffic command and control.

Program Milestones

Implementation of ADS will be at the Oakland and New York Centers only. Oakland Center is scheduled for April 1996.

Products

- ADS mod operational at Oceanic Development Facility (ODF)
- Perform engineering/HF trials
- Complete avionics development support standards
- Develop international ADS standards and operational procedures (SOPS)
- Develop minimum operational performance standards (MOPS)
- ADS installed at Oakland and New York Centers

H.2.22 Automated En Route Air Traffic Control (AERA)

Responsible Division: AAP-200
Contact Person: Gary Rowland, 202/376-6559

Purpose

To provide an interactive software capability within the en route ATC automation system that is more accommodating to the routing preferences of the airspace users.

Specifically, AERA will provide the capability to: (1) permit most aircraft on IFR flight plans to fly user-preferred direct routes and altitude profiles, which will result in time and fuel savings, (2) increase the safety of the system by reducing the potential for operational errors, (3) increase system capacity by integrating en route metering with local and national flow control, and (4) increase controller productivity by increasing the number of control services that a control team can safely manage.

AERA, when fully integrated into the en route automation system evolving from the Initial Sector Suite System (ISSS), was planned for implementation in two steps, Introductory AERA Services (IAS) and Full AERA Services (FAS). IAS was envisaged as an interim step for ease of transition, risk reduction, and early provision of benefits. IAS uses the four-dimensional flight path trajectory modeling to support the following features:

- Flight plan conflict probe ,which will predict potential violations of separation standards between aircraft and between aircraft and special use (e.g., restricted) airspace
- Sector workload analysis, which will calculate and display personnel workload measures to supervisors and specialists to assist them in balancing sector staffing levels
- Trial flight plan function, which will allow controllers to evaluate alternative clearances prior to issuing them to aircraft
- Automated reconformance, which will adjust the calculated trajectory to reflect the aircraft's actual flight path and notify the controller of each adjustment in order to maintain system safety
- Automated replan, which will aid the controller in granting conflict-free user requests at the earliest possible time

Approximately one year after the implementation of the integrated IAS, the remaining FAS capabilities will be implemented. These extend IAS from detecting potential conflicts to providing the controller with suggested resolutions. The automation generated resolutions will avoid the predicted conflict, not cause additional conflicts and minimize the deviation from the aircraft's preferred route.

In 1993, a plan for Early AERA was generated. The objectives of Early AERA are to:

- Take advantage of emerging AAS technology to introduce AERA to sector controllers earlier than possible with the fully integrated IAS/FAS implementation approach
- Implement with minimum impact on ISSS development schedule and cost
- Reduce the risk to implementation of IAS and FAS
- Provide benefits to airspace users earlier than otherwise possible

Each AERA development package will undergo a series of rigorous engineering and validation steps consisting of algorithmic development, operational suitability evaluations, computer performance functional specification generation, software design and development, and comprehensive operational test and evaluation.

Program Milestones

Functional specifications for the AERA 1 functions were completed in FY84. AERA 1 research and development was completed in early FY85. Modifications to the original AERA 1 functionality were made in FY92 to transform AERA 1 into Introductory AERA Services (IAS). IAS development, operational evaluation, and implementation will be accomplished as part of the AAS contract.

AERA 2 functional specifications were completed in FY86. Prototype laboratory evaluations were completed in FY90, and detailed algorithmic and computer/human interaction specifications were produced.

AERA 2 design and analysis began in FY90 as part of the AAS contract. In FY92, activities were adjusted to accommodate the revised approach to Full AERA Services implementation. AERA 2's automated problem resolution capability and supporting functions will continue to be designed and developed as part of the AAS contract in coordination with IAS development. This software will undergo operational evaluations in ATC laboratory simulations. After operational suitability has been demonstrated, the software will be finalized and implemented.

From December 1991 through November 1992: (1) AAS specifications were revised to reflect the new approach to Full AERA Services implementation; (2) AERA design activities under the revised implementation approach continued and algorithmic and computer-human interface risk reduction demonstrations were conducted; (3) analysis of the extendibility of the detailed

ACCC design to IAS was completed, as well as preliminary extendibility analysis to FAS.

In 1993 and early 1994, a high-level strategic plan was generated for an Early AERA functionality and procurement approach. Meetings were held with the AERA team to generate operational concepts for providing AERA benefits early , and an early AERA core requirements review was conducted. Planning meetings for integrating AERA and other new systems into the post-ISSS en route system have been initiated.

Products

- AERA will provide key en route traffic conditions and prediction data to the Traffic Management System (TMS). The upgraded traffic management system will be integrated with AERA to keep both short- and long term traffic planning coordinated
- The AAS ACCC step has been replanned to include IAS and FAS incremental development, as well as Early AERA benefits
- Weather products provided by the Center Weather Processor (CWP) will be used by AERA. More accurate wind data will improve AERA performance
- Aeronautical Data-Link, interfaced through AAS, will provide automated controller/pilot data and advisory interchange

H.3 Communications, Navigation, and Surveillance

H.3.1 Aeronautical Data Link Communications and Applications (031-110)

Responsible Division: ARD-60
Contact Person: Ron Jones, 202/287-7088

Purpose

To develop and validate domestic and international data communications standards and data link services associated with the Aeronautical Telecommunications Network (ATN) as well as special purpose air/ground data link capabilities.

To provide the technical framework for all NAS systems that plan to implement data link services and applications.

Communications

Communications standards for aviation use will be developed, validated, and standardized. Domestic standards are being developed with the Radio Technical Commission for Aeronautics (RTCA) and international standards with ICAO. ATN standards are currently being validated with industry participation.

Extended use of the Mode S Squitter for delivering GPS-based aircraft position reports will be investigated. This automatic dependent surveillance (ADS) concept will provide a technology that will support airport surface traffic automation (ASTA) in developing an airport surface surveillance system. Also, this technology will serve as a basis for future cockpit traffic information systems.

Applications

Data link services in oceanic, en route, terminal, and tower environments are being defined through a coordinated effort between the air traffic and aviation user communities and will be developed and evaluated by a team made up of air traffic controllers, pilots, and other system users. Demonstrations will be conducted with both ground and airborne system users to validate overall operational system effectiveness.

Operational and procedural benefits of data link applications will be verified using full-fidelity airborne and ground simulation facilities. The tower ATC services will be evaluated at selected airports in a fully operational environment with participating air carriers. Routine and hazardous weather applications will be demonstrated and evaluated in various simulation and airborne testbed facilities. Weather and aeronautical services such as traffic advisories, digital automatic terminal information service (ATIS), and ADS-Mode S Squitter applications will also be validated using this approach.

Program Milestones

In FY94, ATN internetwork communications standards were completed, computer-generated voice and digital ATIS was developed, and RTCA flight information services minimal operational performance standards (MOPS) were completed.

Operational procedures development will continue for ATC air/ground data link applications in the en route, terminal, and tower environments in 1995. First operations for initial terminal ATC data link services are planned for 1996-1997. Operations for initial en route data link services are planned for 1997-1998.

ICAO standards and recommended practices for Mode-S data link and ATN will be published in 1997 for the initial ATN. RE&D activities will continue through 1999 to support development and validation of standards that extend the ATN for international operations and management. ATN research, through a cooperative flight test program sponsored by FAA and industry, will validate ATN standards and will provide ATN operating experience. This will be completed in 1997.

Initial weather and aeronautical data link functions will be deployed in 1996. As a result, functional specifications will be completed in 1997 for the next generation aeronautical and weather data link services, with implementation targeted for the year 2000.

Development efforts will continue on surface/air surveillance applications that use ADS techniques based on GPS aircraft position information. These applications will use Mode-S Squitter for delivering this data to airport surface and terminal surveillance systems. Demonstrations are planned for 1995.

Products

- U.S. and international ATN data communications and applications standards
- Specifications for production automation and communication systems that use/support data link
- Prototype systems to support operational data link service evaluations
- Demonstration test beds for developing advanced weather, flight information, and ATC services
- Testbed for ATN development, evaluation, and validation

H.3.2 Satellite Communications Program (031-120)

Responsible Division: ARD-60
Contact Person: Dennis Weed, 202/287-7091

Purpose

To develop the standards and perform the required testing to support mobile satellite communications (SATCOM) operational use for civil aviation, beginning with oceanic, offshore, and remote regions.

To extend this capability to enhance NAS communications and surveillance functions.

Developing Satellite Communications Data Capabilities for Oceanic and Remote Regions

The FAA will support RTCA Special Committee 165 to develop minimum operational performance standards (MOPS) and ICAO standards and recommended practices (SARPs) for frequency coordination. SARPs validation will be performed using simulation, analysis, testing, and demonstration. A ground test facility will be developed to conduct system end-to-end and radio frequency (RF) tests to validate standards not currently validated by manufacturers' data. Flight tests will be performed to evaluate state-of-the-art equipment and system enhancements. Aeronautical mobile satellite service (AMSS) testing will be conducted with industry and FAA developed equipment. Simulation will be used to evaluate the planned architecture performance.

Developing Satellite Communications Voice Capabilities for Oceanic and Remote Regions

This initiative will provide satellite voice capability between the cockpit and the Air Route Traffic Control Center (ARTCC) in oceanic flight information regions. A guidance document will be produced, in conjunction with RTCA, describing the full range of technical requirements to provide satellite voice capability. An architecture will be developed that will enable controllers to send and receive direct satellite voice communications. Flight trials will be conducted with major airlines to demonstrate and evaluate satellite voice capabilities.

Implementing Satellite Communications Services in Oceanic and Remote Regions

Technical expertise, analyses, and data will be provided to the Communications/Surveillance Operational Implementation Team (C/SOIT) to develop operational regulations and procedures that implement satellite communications. The benefits derived from SATCOM require a combined effort among ATN, ADS, ARTCC automation, and SATCOM. Technical data will be collected from bilateral and multilateral engineering trials. This initiative will integrate real-time end-to-end communications and communication capabilities into the Oceanic Development Facility.

Developing Satellite Communications Services for Selected Domestic Applications

The currently defined oceanic aeronautical mobile satellite service (AMSS) system may have applications in domestic areas such as offshore or mountainous regions where very high frequency (VHF) does not penetrate. It may also be possible to use Low Earth Orbiting or Medium Earth Orbiting systems to provide reliable and efficient data/voice capability that meets domestic requirements at a reasonable cost. This project will conduct feasibility studies and evaluations on lower cost, light-weight satellite communications avionics for general aviation and rotorcraft.

Program Milestones

In FY94, ICAO AMSS SARPs were developed and validated, engineering trials for satellite communications voice capabilities in oceanic and remote regions were conducted, communications/surveillance operational implementation team plan was published, and requirements definition on alternative SATCOM technologies for domestic applications were completed.

Verification of ICAO AMSS MOPS and SARPs will be completed in 1998 for SARPs compliance certification and ICAO approval. RTCA guidance documentation on SATCOM voice avionics will be published in 1995. Architecture provisions based on this documentation will be completed in 1996 for ground interface with FAA equipment. Data collection will continue through 1995 from Pacific and Atlantic engineering trials. This data will be provided to the C/SOIT for regulatory and procedural implementation guidance. The feasibility of lower cost, light-weight SATCOM avionics for general aviation and rotorcraft will be determined in 1996. In 1995, research will be initiated on long term alternatives for providing SATCOM service in domestic areas with planned completion in 1999.

Products

- International aeronautical mobile satellite service (AMSS) standards and recommended practices (SARPS) with ICAO
- Minimum operational performance standards (MOPS) for AMSS with the Radio Technical Commission for Aeronautics (RTCA)
- AMSS voice communications architecture

H.3.3 NAS Telecommunications for the 21st Century (031-130)

Responsible Division: ASE-200
Contact Person: Cindy Peak, 202/287-8621

Purpose

To develop the next generation NAS communications system by evaluating alternatives in new communication technology to satisfy future operational NAS requirements and goals.

The current priority of this project is to improve the air/ground communications system to accommodate the increasing traffic load for the 21st century. Competition for additional frequency spectrum is intense and will constrain internationally allocated VHF frequencies. Expanding VHF system capacity will require new VHF radios for both the FAA and user communities.

The overall objectives of this project are to focus RE&D funding on leveraging new technology, reducing communication system cost, and adhering to a disciplined systems engineering approach.

New technologies will be explored to quantify their performance in meeting NAS capacity and reliability requirements. Key factors include using commercial equipment whenever possible, streamlining operations, developing a transition plan, and integrating with other NAS elements. A cost/benefit study will be completed for each potential technology and a tradeoff analysis among alternatives will be performed.

Accommodating evolving national and international communication standards and applying global addressing, routing, and network management technologies will be incorporated into design of the system. System requirements, operational concepts, system design, and appropriate standards will be developed for an air/ground digital voice and data communication system. Technology transfer efforts will be initiated to facilitate industry participation in system development. System elements will be thoroughly prototyped and tested.

Program Milestones

In FY94, a prototype radio system was developed and flight tested. A U.S. position on VHF spectrum utilization for ICAO was developed. Procurement specifications will be prepared in 1995 to support a request for proposal in 1996 with a contract award expected in 1997. Initial installation of the new system is expected to begin in 1998.

Products

- Internationally compatible requirements and standards for a new VHF air/ground communication system
- Operational concept document for the new communication system
- New VHF communication system design specifications
- New VHF communication system prototype, including flight demonstrations
- Request for proposal for system procurement

H.3.4 Satellite Navigation Program (032-110)

Responsible Division: ARD-70
Contact Person: Joe Dorfler, 202/267-7219

Purpose

To develop augmentations to satellite navigation systems, such as the Global Positioning System (GPS), to support procedures, and standards for oceanic, en route, terminal, non-precision approach, precision approach, and airport surface navigation using a single set of required avionics in order to improve safety, capacity, service flexibility, and operating costs.

The initial focus of this program has been to develop standards and methods to use GPS without augmentation as a supplemental aid to meet civil aviation requirements down to non-precision approach. The next phase includes investigating GPS augmented for Required Navigation Performance (RNP), an internationally defined measure of a navigation system's performance within a defined airspace, for en route, airport surface, departure, and precision approach applications, including curved and missed approach guidance. GPS augmented for RNP will constitute a "stand-alone" configuration with required redundancy.

A satellite navigation testbed will be established at the FAA Technical Center to verify theoretical analyses, collect data in a realistic environment, simulate "worst case" scenarios, and provide a means to analyze performance data.

Program Milestones

In FY93, Technical Standard Order (TSO) C-129 for GPS avionics used as a supplemental means of navigation for oceanic and domestic en route, terminal, and non-precision approach flight phases was developed. The FAA Flight Standards and Certification Services authorized the use of C-129 GPS receivers for flight phases down to non-precision approach, other than for localizer-based approaches. In FY94, the first non-precision instrument approach procedure based on GPS Terminal Instrument Procedures (TERPS) criteria was developed. Also in FY94, Minimum Aviation System Performance Standards (MASPS) for Special Category (SCAT) I approaches using local-area differential GPS were published. It is expected that, by the end of FY94, Minimum Operational Performance Standards (MOPS) for GPS avionics augmented for RNP with Long-Range Navigation-C (LORAN-C) and the GPS Wide-Area Augmentation System (WAAS) will be completed. A functional specification for the WAAS was developed, which will support precision approaches throughout the CONUS about 1998. A navigation testbed developed at the FAA Technical Center demonstrated WAAS capability through cross-country flights using WAAS integrity and differential correction information relayed through an International Maritime Satellite (INMARSAT) 2 satellite.

In FY95, MOPS for GPS augmented for RNP using Global Navigation Satellite System (GNSS) and inertial systems will be completed. Demonstrations using GPS for oceanic, domestic en route, and terminal operations and for non-precision and precision approaches will continue. These demonstrations will support the development of standards and operational procedures to permit expanded use of satellite navigation for civil aviation. Research on GPS CAT II/III approach feasibility will be completed by 1995. This research will be used to support the evaluation of candidate navigation architectures for the future NAS.

GPS augmented for RNP is expected to be implemented in oceanic airspace in 1995 and in domestic en route airspace through non-precision approach by 2000. GPS supplemented precision approaches to CAT I will be approved for private use in 1994/1995 and for public use in 1998.

Products

- Satellite-based instrument approach procedures
- MOPS and a TSO for avionics to support use of GPS as a supplemental means in the NAS
- MOPS and TSOs for avionics to meet RNP in the NAS
- Augmentation requirements for GPS to meet civil aviation RNP
- MASPS for SCAT I instrument approaches

H.3.5 Navigation Systems Development (032-120)

Responsible Division: ASE-300
Contact Person: Dave Olsen, 202/287-8763

Purpose

To identify and evaluate technologies and new concepts for future radio-navigation systems and to develop requirements for a smooth transition into satellite-based navigation.

The emphasis of this project is to support the development of a NAS transition strategy that will provide guidance for a major shift to satellite technology. The project will focus on resolving current navigation system supportability, the transition to satellite-based navigation, and potential phase-out of ground-based systems. This project also supports the Federal Radio-Navigation Plan (FRP) biennial revision and provides input to the joint Department of Transportation (DOT) and Department of Defense (DOD) Positioning & Navigation (POS/NAV) Group.

Research will continue on current ground-based system supportability issues until a transition to satellite technology is completed. Potential operating cost reductions, performance enhancements, or new functional additions to navigation aids now operated by the FAA will be identified. The potential to enhance navigation aids will be examined and available technology will be identified. Algorithms for enhancements will be developed and applied in laboratory simulations to test their effectiveness. One example of this is improving the VOR antenna system to reduce sensitivity to the site environments.

Studies and analyses will be performed to support completion of the concept of Required Navigation Performance (RNP) for final approach and landing operations. The results from these efforts will be used to develop recommendations on the RNP criteria. The recommendations will be provided to the ICAO All Weather Operations Panel (AWOP), the Satellite Operational Implementation Team (SOIT), and RTCA, Inc. special committees for incorporation into appropriate standards.

Studies and analyses will be performed to support the FRP. Based on research results, recommendations will be made on the appropriate system mix to be included in the FRP. A national aviation standard will then be prepared and maintained for each system approved for use in the NAS.

Program Milestones

In FY94, an intitial capability was developed to issue NOTAMS on GPS satelite outages. Further work is underway to develop airport specific GPS NOTAMS. The 1994 Federal Radio-Navigation Plan will be published in December 1994. Support to the development of a NAS transition strategy will continue, and a recommended strategy will be provided in 1995.

National aviation standards for the GPS/LORAN-C and GPS Integrity Broadcast/Wide Area Augmentation System (GIB/WAAS) will be developed in 1996. These standards will be used by manufacturers to develop Technical Standard Order approved equipment. Research on current navigation system supportability for VOR, NDB, and TACAN will be completed in 1995, leading to a recommendation on replacement system procurement.

Work will begin on developing the next edition of the Federal Radio-Navigation Plan in 1995. A final GPS NOTAM capability will be implemented in 1997 to support GPS RNP requirements.

Products

- Support development of a NAS transition strategy
- Reports on enhancing performance and reducing costs of existing ground navigation systems
- GPS notice to airmen (NOTAM) capability
- National aviation standards for radio-navigation systems
- Recommendation for the NAS system mix
- Biennial FRP publication

H.3.6 Terminal Area Surveillance System (033-110)

Responsible Division: ARD-90
Contact Person: Jim Rogers, 202/267-9077

Purpose

To develop the next generation terminal area surveillance system (TASS) by defining system requirements, determining future operational concepts, assessing emerging technology applicability, benefits, and risks, and developing advanced capabilities in weather and aircraft detection and weather prediction.

More timely and accurate aircraft and weather detection capabilities will reduce system delays and separation criteria. The next generation TASS will be able to detect dry microbursts at useful ranges; measure wind fields from which wake vortex predictions can be made; detect ice, water, hail, and tornadoes; and support aircraft surveillance operations with seamless coverage and flexible routing tailored to the specific terminal site.

Operations research analysis techniques will be used to assess and identify practical airspace safety and capacity enhancing features in emerging technology. New terminal surveillance sensors will use a modular architecture to provide for site adaptation and upgrade at minimal cost. One option analyzed may be to combine primary surveillance radar and hazardous/non-hazardous weather detection in a single high data rate multi-function radar. For all options analyzed, the potential cost savings will be balanced against the additional program risk that may be incurred. Demonstration experiments will be conducted to reduce the potential risk of future development. The results from these experiments will lead to multiple selections for prototype development and testing.

Program Milestones

In FY94, TASS operational requirements were defined and a simulation program established to quantify benefits and reduce technical risks. TASS alternative analyses will be completed in FY95, and contracts will be awarded for demonstration/validation (DEMVAL) of selected designs. The DEMVAL phase will be completed in FY99, and a contract will be awarded for full-scale development of the best design. A production contract is planned for FY02.

Products

- Operational requirements and design concepts
- Technical requirements feasibility assessments
- Full-scale development prototype
- Production contract

H.4 Weather

H.4.1 Aviation Weather Analysis and Forecasting (041-110)

Responsible Division: ARD-80
Contact Person: Ken Klasinski, 202/287-7081

Purpose

To participate in interagency activities to better understand aviation weather phenomena such as icing forecasts; en route and transition turbulence, ceiling, and visibility; thunderstorm and microburst prediction; wind analysis and forecasting; and oceanic weather observation, analysis, and forecasting.

To develop models and algorithms for generating nowcast and short-term aviation specific products.

To develop and test computer-aided training modules for the users of newly developed forecasting methods and products.

The U.S. Weather Research Program (USWRP) is a congressionally-mandated interagency program under the lead of the National Oceanic and Atmospheric Administration (NOAA). The FAA will participate in the USWRP to address regional and local scale weather phenomena that are unique to aviation.

The major objective for icing forecasting improvements is to develop an aircraft structural icing forecast capability that will provide accurate delineation of actual and expected icing areas by location, altitude, duration, and potential severity. Added capabilities include the ability to forecast the onset, intensity, and cessation of structural icing on the ground to support deicing activities.

The major objective for detecting and avoiding clear air turbulence will be to develop a model for short-term en route and transition turbulence forecasting using wind, temperature, and moisture data. A variety of models will be developed and applied to forecasting wind flow patterns, downbursts, wind direction changes, wind shear, and gust fronts for the lower atmosphere.

This research is being coordinated with and accomplished through an interagency agreement with the National Science Foundation, National Center for Atmospheric Research, and universities. Prototype products developed through the Aviation Weather Analysis and Forecasting Project will be tested and evaluated by the Aviation Weather Development Laboratory (AWDL) at Boulder, Colorado and the Experimental Forecast Facility (EFF) at Kansas City, Missouri.

Program Milestones

In FY94 winter icing forecasting techniques were field tested at Denver ARTCC.

Field testing and demonstrations on winter icing forecasting techniques for the Chicago and east coast ARTCCs will be accomplished in 1996 and 1998, respectively. Denver test results will undergo analysis at the Aviation Weather Development Laboratory in 1995, Chicago results in 1997, and east coast results in 1999. Improvements in icing forecasts will continue in 2000 using high resolution humidity data available from the airborne humidity sensor being developed by the Airborne Meteorological Sensors Project.

In 1995, research will continue on automating forecasted changes in ceiling and visibility at airports. This development will transition to the Integrated Terminal Weather System/Aviation Weather Products Generator in 1998. Further improvements will be developed between 1998 and 2000 using the high resolution humidity data from the airborne humidity sensor.

Products

- Precise and usable algorithms and/or numerical models related to icing, turbulence, convective initiation, visibility, ceiling, and snowstorm forecasting
- New mesoscale numerical data assimilation and prediction models adapted to aviation needs and new methods for nowcasting
- New prototype aviation weather products of AWDL and EFF test and evaluation
- Automated techniques for detecting, quantifying, and forecasting meteorological events

H.4.2 Airborne Meteorological Sensors (041-120)

Responsible Division: ARD-80
Contact Person: Ken Klasinski, 202/287-7081

Purpose

To develop specialized airborne meteorological sensors to provide three-dimensional basic meteorological data needed to create accurate icing, turbulence, and visibility forecast products to provide early hazardous weather warning in the terminal area and en route airspace.

This project will develop meteorological sensors to measure humidity and icing that can be carried aboard aircraft to provide near real-time three-dimensional weather data that is currently not available from remote sensors. The data obtained from these airborne sensors will automatically be transferred to FAA and the National Weather Service weather processing systems by the Meteorological Data Collection and Reporting System (MDCRS) operated by ARINC.

The technology developed will provide design guidelines and engineering data to support industry production and certification initiatives for airborne meteorological sensors. Aviation weather products that are developed as a result of these sensors will be provided to air carriers in the test and validation phase to validate the user requirements and encourage rapid deployment in the air carrier fleet. Prototype airborne sensors will be evaluated in conjunction with the operational testing of the Integrated Terminal Weather System and Aviation Weather Products Generator.

Research will be carried out to determine the most cost-effective approach for providing a turbulence index, or rather, an index that determines how various aircraft respond to turbulence encounters. Airframe motion estimates of turbulence must be corrected for airspeed, wing loading, and airframe type to give a universal turbulence index. Candidate designs will be tested in an aircraft and the resulting predictions compared with the results of turbulence encounters. Algorithms to estimate turbulence areas will be developed and tested operationally at the Integrated Terminal Weather System and Aviation Weather Products Generator prototype test sites.

Program Milestones

In FY94, a Request For Proposal (RFP) for a prototype humidity sensor and sensor flight certification was initiated. Also, turbulence index algorithms were developed. In 1995-1996, experimental humidity sensors will undergo flight test evaluation/demonstration and operational utility assessments. If these assessments suggest a significant cost-benefit from more rapid humidity profile updates, multiple off-the-shelf sensors will be recommended for procurement in 1997.

The turbulence index algorithm will be flight tested in 1995-1996 to determine the correlation between the index and aircraft performance. This algorithm will be passed on to air carriers in 1997 for implementation.

In 1998, work will begin on detecting icing aloft using both ground-based and airborne sensors.

Products

- Prototype humidity and icing sensors
- Certification of sensors that measure humidity and icing aboard air carrier aircraft
- Design guidelines, engineering data, and functional requirements for the sensors
- Turbulence index algorithms for using the sensor data to provide improved turbulence products
- Automated humidity and clear air turbulence reports downlinked from air carrier aircraft

H.4.3 Integrated Airborne Wind Shear Research (042-110)

Responsible Division: ARD-200
Contact Person: Cliff Hay, 202/267-3021

Purpose

To develop, test, and analyze systems that provide an improved operational capability to detect, monitor, and alert flight crews to wind shear hazards.

This project is divided into two areas. The first, airborne wind shear advanced technology, addresses the equipment certification issues. The second, wind shear training applications for Federal Aviation Regulations (FAR) Parts 91 and 135, addresses the training and flight crew certification issues.

Airborne Wind Shear Advanced Technology

This work will support the development of standards for airborne wind shear equipment and is being accomplished through a cooperative agreement with the National Aeronautics and Space Administration (NASA). The technology developed will provide design guidelines and engineering data to support industry production and certification initiatives for advanced wind shear warning systems and flight crew decision aids. The data will be provided to FAA certification, regulatory, and compliance offices. The technology will be transferred to manufacturers and operators to accelerate their development and certification programs resulting from FAR 121.358 requirements.

Flight tests will be conducted to evaluate onboard airborne wind shear sensor performance by flying the test aircraft into wind shear conditions. Additional flight tests will uplink and evaluate available ground products to support time-critical information processing and display in the cockpit. The ground-based ATC system will be supplied airborne-derived information via downlink.

Further research will investigate new applications for wind shear sensor technology with an integrated systems approach developed in the joint NASA/FAA wind shear program. Results from this research will be applied to clear air phenomena.

Wind Shear Training Applications for FAR Parts 91 and 135

The first task of this project will be to define the issues of implementing wind shear pilot certification in the field. This will combine all the FAR Parts 91, 135, and 121 products into a comprehensive set of documents. The next task will be to define pilot certification requirements for wind shear escape and recovery.

The overall wind shear training applications portion is being carried out in three phases. Phase 1 dealt with crew examination, Phase 2 is developing the four wind shear products, and Phase 3 will address wind shear training support issues.

Program Milestones

In FY94, mountain rotor hazard characterization and definition was completed. Also, Phase 3 of Wind Shear Training Applications for FAR Parts 91 and 135 was completed. This successfully concludes this research area.

Further research in airborne wind shear advanced technology will concentrate on three specific clear air phenomena: mountain rotor, clear air turbulence, and wake vortices. For all three areas, a method will be developed to characterize and measure the phenomena and then advanced sensor technology will be applied to detect and provide a hazard warning.

Mountain rotor research and flight tests will be completed in 1995 and sensor development is expected for 1996. Definition of wake vortices will continue in 1995, as will flight tests, with sensor development expected in 1997. Clear air turbulence research efforts will begin in 1996, with flight tests expected in 1997, and sensor development in 1999. A final demonstration of sensor capabilities will include a Category II low visibility approach for closely-spaced parallel runway operations. Advanced sensor development for low visibility surface operations will begin in 1997.

This project will integrate the output from airborne and ground-based systems to ensure the detection, warning, and avoidance of hazardous clear air phenomena. This integration will be accomplished in conjunction with air traffic control during the development cycle for the three major areas of research.

Products

- Recommendations based on study of wind shear effects on aircraft performance
- Atmospheric model for lowest 1,000 feet of the atmosphere
- Sensor technology assessments for microwave radar, coherent pulsed lidar, and passive infrared and sensor integration into the flight deck
- Wind shear hazard algorithm used with ground-to-air data link to provide information on the flight deck
- Operational requirements for airborne wind shear warnings

H.4.4 Integrated Terminal Weather System (ITWS)

Responsible Division: ARD-80
Contact Person: Ken Klasinski, 202/287-7081

Purpose

To develop a system that will integrate all the terminal weather sensors to provide near-term automated weather information and predictions in easily understood graphical form.

Air traffic controllers in tower cab and TRACON facilities rely on a number of terminal area weather sensors, which collectively provide large amounts of data. The interpretation of this data is performed manually and is labor intensive, and the data from the various sensors may be confusing. The need to interpret large amounts of confusing data interferes with normal air traffic control functions. However, the main shortcoming of the present system is that it cannot anticipate short-term weather changes that affect safety, capacity, and efficiency. Specifically the present system cannot accurately predict changes in weather elements, e.g., ceiling, visibility, wind shear, microbursts, and thunderstorms, and the impact of these changes on terminal area operations.

The ITWS is focused on providing safety and planning products to Air Traffic Control Specialists (ATCSs) from the current time out to about 30 minutes. It will collect all of the weather data available in the airport terminal area, from both ground-based and airborne sensors. These include Next Generation Weather Radar (NEXRAD), Terminal Doppler Weather Radar (TDWR), Automated Weather Observing System (AWOS)/Automated Surface Observation System (ASOS), Low-Level Wind Shear Alert System (LLWAS), and aircraft-reported data via the congressionally mandated Meteorological Data Collection and Reporting System (MDCRS). These products include wind shear and microburst warnings, storm cell information, lightning that may affect airport operations, terminal area winds aloft, runway winds, short-term ceiling and visibility predictions, and snowfall rate predictions to assist in ground de-icing decisions.

Program Milestones

The ITWS will be deployed at the 45 airports associated with the TDWR. Initial deployment of the ITWS will provide well-defined, beneficial products available as an initial systems capability, followed by enhancement packages when both the required input systems and algorithms become available. The ITWS is in the demonstration/validation phase. Demonstration sites are Orlando, Dallas-Fort Worth, and Memphis International Airports.

H.4.5 Aviation Weather Products Generator (AWPG)

Responsible Division: ARD-80
Contact Person: Ken Klasinski, 202/287-7081

Purpose

To produce high-resolution, accurate, and timely automated graphical predictions of weather variables that impact aviation, such as icing and turbulence, which will be easily understood by air traffic control specialists (ATCSs).

Accurate weather forecasts are not available in the en route domain of the National Airspace System (NAS) on a time scale comparable to that of other U.S. flights, i.e., 30 minutes to several hours. Current weather information systems can only report the present state of the weather and forecast future weather with very low resolution. National Weather Service (NWS) forecasts are based on 12-hourly observations spaced 200 miles apart across the U.S. With these observational limitations, the high-resolution forecasts needed by the aviation community are not available or possible. Continued manual analysis, such as that performed by NWS meteorologists to identify specific aviation weather impacts, e.g., icing and turbulence, cannot provide the product timeliness and resolution required to significantly reduce related delays. On a national scale, the poor forecast resolution and slow update frequency result in advisories that are ineffective due to broad overwarning. Also, the present system does not provide the graphical depiction of aviation weather impacts necessary to promote rapid assimilation by ATCSs.

The AWPG program will be a joint effort with the NWS and will capitalize on their new super-computing capabilities, the increased resolution of the national weather data base through new sensor systems such as NEXRAD and wind profilers, the development of models dealing with small-scale weather phenomenon that are of major importance to aviation, and the automatic conversion of the NWS computer generated weather data forecasts to weather information that impacts aviation. These efforts by the NWS will be made possible through the development of the Aviation Gridded Forecast System (AGFS), which will produce the automated prediction of weather variables that impact aviation.

The AWPG will receive weather forecast data from the NWS and generate specific weather observation, warning, and forecast products to ATCSs in Automated Flight Service Stations (AFSSs), Air Route Traffic Control Centers (ARTCCs), and the Air Route Traffic Control System Command Center (ATCSCC), without intervening meteorological interpretation. This capability will be made available to users via existing and planned NAS platforms, e.g., WARP.

The AWPG is divided into two components, an analysis and forecast component and a product generation component. The first component is the Aviation Gridded Forecast System (AGFS) that is being developed for the FAA by NOAA's Forecast Systems Laboratory. It will provide the numerical and statistical techniques to automatically generate a high-resolution analysis and forecast of aviation impact variables (AIVs), namely winds, temperature, icing, turbulence, cloud base height, visibility, hail, and convective precipitation. The AGFS will be incorporated into the NWS supercomputer software for operational generation of AIVs.

The second component, AWPG product generation software, is being developed to convert the AFGS into user-specific products for use by air traffic controllers. As new products are developed and tested, they will be incorporated into existing and planned NAS subsystems as preplanned product improvements.

The AWPG product generation development is being transferred to private industry. Use of Cooperative Research and Development Agreements with private weather service companies will be utilized throughout the product demonstration and validation period.

A vital input to the model generation of the AGFS is aircraft reported data via the congressionally mandated MDCRS.

Program Milestones

The AWPG is in the demonstration/validation phase. Demonstration sites include Minneapolis ARTCC, Fort Worth ARTCC, Fort Worth AFSS, Denver AFSS, and the ATCSCC.

H.5 Airport Technology

H.5.1 Airport Planning and Design Technology (051-110)

Responsible Division: ACD-100
Contact Person: Satish Agrawal, 609/485-6686

Purpose

To improve existing design standards pertaining to runways, taxiways, aprons, and gates and develop standards and advisory information to be used in planning and designing airports, terminals, and ground access systems.

Ever increasing travel demand and projected growth in traffic in the next 15 years will influence airport design, layout, and configuration, and require improved landside facilities. A major concern facing the U.S. air transportation industry is how to manage increases in air traffic with improved safety, reduced delays, and minimal operational constraints.

As advances in air traffic control and other airport improvements increase airside efficiency and capacity, passenger facility capacity and access to the airport will become a limiting factor. Optimum airport utilization will require that there be a smooth and uninterrupted flow of passengers, cargo, and airplanes between the various elements of the airport system.

The goal of this program is to eliminate runway acceptance rate as a limiting factor in maximizing airport capacity. This will be achieved by reducing the runway occupancy time as much as practical. It will also require optimizing the geometry of runway and taxiway exits which will allow aircraft to negotiate turns safely at higher speeds. Research will also be conducted to optimize existing airport facility designs to balance the relationships between access roads for public and private transportation and parking lots. Clearances and design requirements of future aircraft will be identified and the adequacy of current airport designs for those requirements will be reviewed. Simplified methods will be developed for determining terminal, curbside, and airside capacities.

Program Milestones

In FY94, an analysis on current airport designs for compatibility with new transport aircraft was completed. Also, an airport accessibility index tool was developed.

In 1995, an initial taxiway system design and flow rate evaluation for triple and quadruple parallel runways will continue and design standards will be completed. Design advisory circulars will be re-examined to determine how airports should be planned and designed to accommodate new unique aircraft configurations with larger wingspans. Standards for the Boeing 777 will be completed in 1995 and standards for future growth aircraft will be completed in 1997.

Planning guidance for ground access to airports and for terminal building design will be developed in 1995 and an airport financial performance review will be completed in 1996.

Products

- Technical data to support advisory material, regulations, and guidance used by industry and the FAA
- Computer programs and user guides for use by industry and the FAA airport community
- Design standards for terminals and parallel runway configurations
- Terminal design simulation guidance and models
- Aircraft/terminal compatibility analyses

H.5.2 Airport Pavement Technology (051-120)

Responsible Division: ACD-100
Contact Person: Satish Agrawal, 609/485-6686

Purpose

To reduce the massive costs of pavement expenditure by at least 10 percent by the year 2010 through a research program featuring: (1) pavement design and evaluation, (2) materials and construction methods, and (3) repairs and maintenance techniques.

There are approximately 650 million square yards of pavement at U.S. airports. Replacement value is expected to exceed $100 billion and there are limited practical possibilities for adding to or replacing major pavement systems. The Federal Government and the aviation community are spending approximately $2 billion annually on pavement as well as additional costs of delay resulting from operational interruptions due to construction and maintenance. A significant portion of the $2 billion is spent replacing, repaving, rehabilitating, repairing, and maintaining pavement surfaces. During this decade, an estimated $40.5 billion in federal and local funds will be required to provide a more efficient and integrated public-use airport system under the FAA's National Plan of Integrated Airport Systems (NPIAS). Of this total, about $17 billion will be spent on constructing, maintaining, and rehabilitating airport pavements. The majority of this money will be spent at the most heavily used airports carrying the largest aircraft.

Specific projects will be undertaken to develop an advanced method for pavement design that will reduce pavement design and construction costs, pavement failures, maintenance costs, pavement down time, and aircraft delay costs. Initially, a pavement design method based on layered elastic theory will support U.S. aircraft manufacturer efforts to introduce new and heavier aircraft. An internationally accepted basis for evaluating if airports can accommodate new aircraft will be provided. Methods for nighttime and cold weather construction will be developed and methods for pavement evaluation and failure prediction will be improved in order to extend pavement life by at least 20 percent.

Pavement Design and Evaluation

Research in pavement design and evaluation area will focus on developing an advanced pavement design method that can be applied to the design of both flexible and rigid pavements. Efforts will first be concentrated on completing the layered elastic design method followed by more rigorous design methods such as finite element analysis to accurately model material properties. As part of validation of the layered elastic theory, full-scale pavement testing will be required using a facility that can accommodate multi-wheel configurations simulating the newer aircraft. The facility will provide aircraft response and pavement performance characteristics accurately. Evaluation of aircraft response and pavement performance will also be initiated at major new airports by installing advanced instrumentation and sensor systems in runways and taxiways. Research will also be conducted to develop design criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions.

Pavement Materials and Construction

Research in this area will include: developing methods to specify and use new or improved materials as substitutes for the conventional materials used for pavement construction; identifying factors affecting the durability of airport pavements and development of criteria for efficient use of devices, construction materials, and construction techniques; performing evaluation of coal-tar mixes; using roller-compacted concrete as a construction technique; and using geotextiles and grid type materials for strengthening airport pavements.

A new program will be initiated for organizing long-term data collection on pavement performance modeled on the Strategic Highway Research Program. This new program will be known as the National Airport Pavement Registry and Demonstration Program and will annually identify significant new airport construction to determine life-cycle costs and other performance factors.

Pavement Maintenance and Repairs

Research efforts in this area will include: determining probable causes of significant distress and life-cycle cost of pavements and developing criteria and guidance to effectively use seal-coating materials for enhancing pavement longevity.

Special life-cycle cost studies on heavy concrete pavements at Dulles and Dallas-Fort Worth Airports will be carried out because these pavements are at the end of their design lives. Pavement sections that show significantly more or less distress than average will be identified and their condition related to the number of stress repetitions, subsurface conditions, and other factors. The results will be used to develop guidelines for concrete pavement average life span, life-cycle costs, and to support developing new design methodologies.

Program Milestones

In FY94, layered elastic theory development was completed and design specifications for the National Pavement Test Machine were completed.

In 1995, the ten-year runway data collection effort will continue at the new Denver Airport using the newly installed pavement sensors. These sensors will measure the pavement response to repeated heavy aircraft loading. The data collected will be used to validate pavement design theories. This data collection effort will be completed in 2002. Computer software development using the predictive design and analysis methodology will continue in 1995, resulting in a stress-strain graphic display in 1999. New tests for material characterization will be completed in 1998 and controlled experiments under various applied and environmental loading conditions will be formulated to assure the methodology's accuracy. Studies will be initiated on durability of asphalt mixes and improved shoulder designs.

In 1995, work will continue on collecting and analyzing data that relate pavement performance to FAA design and construction standards. This effort will result in a comprehensive airport pavement data base in 2001. Criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions will be completed.

In 1995, studies on pavement life-cycle costs and the National Airport Pavement Registry and Demonstration Program will be completed. Also in that year, national pavement test machine development will be completed. Pavement design tools based on layered elastic analysis and/or finite element analysis will be completed in 1997.

Products

- Technical data for pavement design and design life, evaluation, materials, construction, maintenance, and repair
- Software and user guidelines for pavement design and analysis
- National pavement test capability
- Pavement design tool

H.5.3 Airport Safety Technology (051-130)

Responsible Division:	ACD-100
Contact Person:	Satish Agrawal, 609/485-6686

Purpose

To develop new technologies in four research areas: (1) safe and efficient aircraft operations on runway surfaces; (2) new emerging technologies in lighting, signing, and marking materials for improved visual control systems; (3) new materials, methods, and equipment to improve the capability and cost-effectiveness of airport rescue and firefighting services; and (4) materials, methods, and devices to control birds and wildlife in the airport environment.

Runway Surface Technology

The condition of the runway surface is a critical concern at airports. Snow, ice, water, and rubber deposits can result in slipperiness, causing aircraft to lose control during braking and making surface movements hazardous. In recent years, grooved runways to control surface water have greatly reduced hydroplaning. However, aircraft accidents from overshooting or veering off contaminated runways remain a problem.

During the last 11 years, there have been 130 accidents involving aircraft overruns and veeroffs. The accidents involved runway surfaces that were either dry or covered with water, ice, snow, or slush. The three major aircraft accidents during the last 10 years have focused national attention to the question of runway slipperiness and loss of control during landings and takeoffs.

The goals of this program are to eliminate runway slipperiness as a cause of accidents by the year 2000 and to stop all aircraft within the extent of the runway. To achieve this goal, extensive research, testing, and evaluation will be conducted to develop new techniques, materials, procedures, and equipment to efficiently remove ice, snow, and rubber deposits. Also, research will continue on developing methods to prevent ice and snow accumulation on airport surfaces. New materials and methods will be investigated to decelerate aircraft safely, should there be an overrun.

Visual Guidance

Safe and efficient airport ground operations, especially at night and under low visibility conditions, require that pilots and vehicle operators receive conspicuous and unambiguous information from lights, signs, and other markings. Improvements in these visual aids are one of the key elements in the FAA's Runway Incursion Program.

During the past 15 years, there have been seven air transport surface collision events in the U.S. These accidents have brought into focus the need for providing visual guidance to aircraft in low visibility conditions.

The goal of this program area is to eliminate, by the year 1997, deficiencies in the visual guidance systems and procedures that may contribute to surface collision accidents. This goal would require research efforts in two general areas: visual guidance "control" technology to develop an automated system for aircraft movement on airport surfaces, and developing state-of-the-art light sources and applications. These will include fiber optics, laser sources, and holographic techniques. Technology will also be developed to evaluate new visual guidance systems and procedures, particularly during low visibility conditions, on a computer-based simulation system.

Rescue and Firefighting

The analysis of aircraft accidents involving external fuel fires has shown that, although external fire is effectively extinguished, secondary fires within the fuselage are difficult to control with existing equipment and procedures. Large amounts of smoke, toxic gases, and high temperature levels in the passenger cabin can cause delay in evacuation and pose severe safety hazards. Reductions in off-runway response times will be achieved by developing a new truck suspension system that improves traction in soft sand, wet, and uneven ground conditions.

The goal of this program area is to increase passenger survival rate in post-crash fires by providing a safe evacuation route through the aircraft cabin in a timely manner. This goal would require research and testing to develop firefighting systems that can effectively be used to control both external and internal cabin fires. Research will be conducted to reduce vehicle response times during nighttime and in low visibility conditions to develop new training techniques for rescue and firefighting personnel. Improvements in response times and proper equipment development are needed for operations in poor visibility conditions.

Improvements in soft terrain and off-road firefighting vehicle capabilities will be needed to cope with expanded airport runway configurations into the year 2000 and beyond. New methods, procedures, and firefighting chemicals will be developed for use with large capacity aircraft, double-decked aircraft, and/or aircraft made from advanced materials.

Chemicals used in firefighting training facilities are raising concerns about environmental damage. Research will investigate methods to maintain a high level of performance for firefighting services, while minimizing air pollution and ground water contamination.

Wildlife

The presence of wildlife at and near airports poses a potential threat to movements of aircraft and other ground vehicles. In spite of various control devices in use to keep birds away, over one thousand incidents of bird strikes are reported every year. Many more incidents are known to occur, but are not reported.

The goals of this program are to increase airport safety and decrease damage to aircraft by reducing bird strikes. These goals require research efforts in developing effective regional wildlife habitat management to minimize or eliminate sources of bird attraction at airports. Research will also be conducted to identify active and passive harassment techniques that can effectively control the presence of birds and other wildlife at airports. These techniques and methods will help airport owners and operators in complying with FAA airport certification regulations. Land use sighting compatibility guidance will be provided by researching relationships among birds, airports, and landfills.

Program Milestones

In FY94, installation standards for a plastic foam arrestor system were completed, a technical report on runway sand application rates was completed, technical data for developing U.S. runway stop-bar standards was provided, an advisory circular on minimum rescue and firefighting capabilities at general aviation airports was published, and the third report on wildlife harassment/deterrent techniques for airports was also published. Specifications for a firefighting penetrating nozzle boom and standards for fire extinguishing agents to replace Halon 1211 were developed in FY94.

Runway Surface Technology

In 1995, standards will be issued on runway sand application rates. In 1996, research will be completed on microwave debonding on runway ice. Also, testing will be completed on innovative methods of ice removal, with a final report in 1997, leading to an advisory circular in 1998. In 1997, a universal performance specification will be completed for removing runway rubber deposits. Also, research will begin on advanced aircraft arresting systems for new generation transport aircraft. Standards for an advanced aircraft arresting system are expected to be issued in 2005.

Visual Guidance

In 1995, standards will be issued for improved airport pavement markings based on technical research into factors such as durability and visibility under dry or wet conditions. Visual simulator enhancements will be completed for testing new and improved lighting systems under all weather conditions. A study on automatic traffic control logic and procedures will be initiated in 1996. This study will lead to developing design standards for an automated taxiway guidance system in 1998. Advanced technology lighting sources will be investigated in 1996 to develop more efficient airport visual guidance systems. The most promising technologies will be integrated into enhanced lighting systems by the year 2000.

Rescue and Firefighting

In 1995, work will continue on evaluating a penetrating nozzle's ability to suppress aircraft cabin fires. A study will continue on identifying the most cost-effective technology to provide enhanced vision and location definition for rescue vehicles responding to emergencies under poor visibility conditions. Work will continue on providing fire truck crews with information for efficient rescue operations following a crash. Efforts will continue on evaluating the rescue firefighting standards against requirements to control and extinguish fires in aircraft containing composite material.

An evaluation will be initiated in 1995 for aircraft rescue and fire fighter training simulators. A study will begin on a generic, full-scale firefighting training facility that meets both environmental concerns and operational requirements. Based on this research, the current training advisory circular will be updated for a standardized, generic firefighting training simulator. This is expected for 1997.

In 1995, an evaluation will be initiated on developing post-crash fire protection requirements for advanced double-decker aircraft seating up to 1000 passengers. In 1997, the current fire protection advisory circular will be updated to include the new generation transport aircraft such as the Boeing 777. It is expected that the advisory circular will be updated in the year 2000 to include fire protection for aircraft in the 600 to 800 passenger capacity and in 2006 to include aircraft up to 1000 passengers.

In 1996, an advisory circular will be published to cover technologies that deal with firefighting procedures for advanced composite aircraft and structures. In 1996, an advisory circular will be published to cover technologies that improve response during poor visibility conditions for firefighting vehicles. Research will be conducted to evaluate soil stabilization methods to support airport rescue and firefighting vehicles.

Wildlife

The second regional airport habitat management study will continue in 1995. Research on a fourth wildlife harassment/deterrent technique and landfill study will continue. The first regional habitat study at Atlantic City will be completed in 1995, with a final report expected in 1996, and a Mid-Atlantic U.S. advisory circular expected in 1997. The third regional habitat study will begin in 1996. Final reports on the fourth and fifth wildlife harassment/deterrent techniques will be finished in 1995 and 1996 respectively. Regional habitat management studies will be initiated and completed at a rate of every two years until the ten regional studies are completed. These regional airport studies are expected to continue through 2008, with advisory circulars published one year after the final reports.

The primary thrust of the above research efforts is to identify and document the effectiveness and applicability of new wildlife habitat management and harassment/deterrent techniques for use on or near airports to mitigate bird or wildlife hazards. Knowledge of bird relationships to existing and new solid waste facilities will establish a sound scientific basis to evaluate potential bird attraction effects on or near airports.

Products

- Technical data supporting rules, regulations, and advisory circulars on runway surface maintenance
- Technical data and design criteria for lighting and marking systems for airports, heliports, and vertiports
- Technical data on tests and evaluation of firefighting agents, full-scale systems, and rapid response all-terrain firefighting vehicle
- Technical data and advisory circulars on wildlife habitat management, bird harassment techniques, and landfill studies

H.5.4 Low-Level Wind Shear Alert System (LLWAS)

Responsible Division: ANW-400
Contact Person: Steve Hodges, 202/267-7849

Purpose

To monitor winds in the terminal area and alert the pilot, through the air traffic controller, when hazardous wind shear conditions are detected, since these conditions occurring at low altitude in the terminal area are hazardous to aircraft encountering them during takeoff or final approach.

Program Milestones

The LLWAS program was initiated in early 1975. Among the sensors evaluated were pressure jump detectors, pulsed and CW Lasers, acoustic Doppler systems, pulsed Doppler radar, and arrays of anemometers. The last technique was selected as the most cost-effective approach. Doppler radar promised the best capability at the time, but the technology was not sufficiently mature and the cost and technical risks were high. Full-scale development began in 1976, resulting in the evaluation of LLWAS at six airports. Production was initiated in 1978, 110 LLWAS units are now operating.

The program to upgrade the systems began in 1985 and contracts were awarded in 1987. The upgrade provided new processors and significantly improved the algorithm which increased the probability of detection and reduced the false alarm rate. This program was completed in the spring of 1991.

The LLWAS-Network Expansion (LLWAS-NE) upgrade, planned for nine airports, will provide improved microburst detection and identification. It will also provide new displays for controllers and provide runway oriented wind shear information. The LLWAS-NE has been operationally tested and evaluated at Orlando International Airport, and, as a result of this testing, software errors are being corrected by the LLWAS-NE contractor. The new Denver International Airport LLWAS-NE was placed in operation February 1994 and will be officially commissioned when the new airport opens. The remaining LLWAS-NEs will be commissioned in 1996. The LLWAS-NE will provide an integrated wind shear alert when the system is collocated with a Terminal Doppler Weather Radar (TDWR).

Products

- One hundred and ten production systems, including spares, training, and documentation.

H.5.5 VORTAC Program

Responsible Division: ANN-300
Contact Person: Charles B. Ochoa, 202/267-6601

Purpose

To form a modern cost-effective national navigation network which provides required coverage through the replacement, relocation, conversion, and establishment of VORTAC, VOR/DME, and VHF Omnidirectional Range Test (VOT).

Very High Frequency Omnidirectional Ranges (VOR) with Distance Measuring Equipment (DME) or Tactical Air Navigation (TACAN) are en route air navigational and approach aids used by pilots to conduct safe and efficient flights and landings.

From FY82 through FY89, the FAA replaced 950 vacuum tube-type VOR and VORTAC systems with modern solid-state equipment. New Remote Maintenance Monitoring compatible DME systems will replace existing DME systems at 40 VOR/DME sites. The DME units removed from these sites will be redeployed to ILS sites. 76 tube-type VOTs have been replaced with solid-state equipment, and 35 new VOT facilities have been established. VOR/DME facilities are being relocated to accommodate route structure changes, real estate considerations, and site suitability. Conventional VORs are being converted to Doppler VORs to solve siting problems and to obtain required signal coverage. Operational requirements that arise in various geographic areas require the establishment of VHF navigational aid services. Provisions have been made to establish 70 VOR/DME sites including new VOR/DME equipment at non-Federal takeover locations. DME systems will be added at 47 sites equipped with VOR only.

Program Milestones

All vacuum tube-type VOR and VORTAC equipment has been replaced with solid-state equipment which has embedded remote monitoring and control capabilities. DME service will be provided at all VOR facilities. A revised network plan will be developed to redistribute VORs to meet operational requirements during the transition from a ground-based navigational system to a satellite-based system. Tube-type VOT equipment has been replaced with solid-state equipment. VOR/DME and VOT sites will be established to meet operational requirements.

In FY90, the VOR/DME contract was awarded, the VOR/DME system design review was completed, and the design qualification test for VOT was completed. Plans are to issue a DME-only contract during FY95. A contract to procure all required Doppler VOR conversion equipment is currently in place.

Products

- To date, 725 VORTACs, 145 VOR/DMEs, and 80 VORs have been replaced, 35 VOTs have been established, and 76 VOTs have been replaced.
- In the next ten years, the FAA plans to establish 70 VOR/DMEs, establish 40 DMEs at VORs, replace 47 DMEs at VORs, reinstall 47 DMEs at ILSs, and convert 94 VORs to DSB DVOR.

H.5.6 Microwave Landing System (MLS)

Responsible Division:	ANN-200
Contact Person:	Gary Skillicorn, 202/267-6675

Purpose

To develop and implement a new common civil/military precision approach and landing system that will meet the full range of user operational requirements well into the future.

MLS is currently the international standard replacement for the Instrument Landing System (ILS), and there are vendors in several countries that manufacture at least the Category I version of the MLS. There are also several manufacturers of the basic avionics sets. Some users are questioning the benefits of equipping with MLS, given possible alternatives of improvements in the ILS and the potential use of satellite-based systems for precision approaches. Other users are willing to equip with MLS to take advantage of its inherent advantages over ILS.

Program Milestones

In 1984, the FAA awarded a contract to Hazeltine Corporation for 178 MLSs. However, the contract was terminated in 1989, and only two systems were delivered. From 1988 to 1992, the FAA conducted a demonstration program to show the economic and operational benefits of MLS. Under this program, the estimated costs associated with various avionics configurations were also generated. In March 1992, a final report on the demonstration program was sent to Congress. All nine projects in the program are complete except the deployment of all Category I MLSs, the DME/P interrogator development, and the delivery of the combined MLS/GPS receiver.

The FAA currently has three contracts for MLS systems. The first contract is with Allied-Signal for the delivery of 26 Category I FAR Part 171 systems. Three of these MLSs were installed. The other two contracts are with Wilcox Corporation and Raytheon Corporation for the design, development, and testing of six first article Category II/III MLSs from each contractor.These two contracts were terminated in 1994. A recommendation on a replacement system for ILS is expected in 1995.

Products

- Category I MLSs (28)

H.5.7 Runway Visual Range (RVR) Systems

Responsible Division: ANN-400
Contact Person: Calvin Miles, 202/267-6038

Purpose

To establish and modernize existing Runway Visual Range (RVR) systems on qualifying Category I, II, III a/b ILS and MLS runways. RVRs support precision approach landing operations.

RVR equipment provides real-time measurement of visual range along the runway. The RVRs in the NAS utilize old technology and cannot be economically upgraded to satisfy the requirements of the NAS in the 1990s and beyond. A new generation RVR has been conceived to economically satisfy all future NAS operating and maintenance requirements.

Program Milestones

A contract has been awarded to procure 528 RVR systems. The RVR systems have completed all factory required testing. Production systems are scheduled for delivery in FY94-95.

Products

- 528 RVR systems with proper documentation

H.5.8 Visual NAVAID Systems

Responsible Division: ANN-300
Contact Person: Charles B. Ochoa, 202/267-6601

Purpose

To provide safety-related and safety enhancement visual NAVAID systems at airports.

The facilities to be provided are: medium intensity approach lighting system with runway alignment indicator lights (MALSR), runway-end identification lights (REIL), precision approach path indicator (PAPI), omnidirectional approach lighting system (ODALS), and standard 2,400 foot high intensity approach lighting system with sequenced flashers (Category II configuration) (ALSF-2).

This program also includes:

- The procurement of equipment for the replacement or establishment of remote radio control capabilities for visual aids that meet the operational requirements of air traffic control and remove complex manually activated coding methods. The new system will permit single-button control of each visual aid function.
- The replacement of the existing rigid approach lighting tower structures with lightweight, low-impact-resistant structures that collapse or break apart upon impact to reduce damage to an aircraft should it strike an approach light tower during departure or landing.
- The installation of threshold light bars to existing MALSR to provide a visual reference to the runway threshold to make the present system more effective in low-visibility conditions.
- The replacement of visual approach slope indicators (VASIs) with PAPIs to satisfy the ICAO recommendation for PAPIs at international runways and to satisfy Air Line Pilot Association (ALPA) and general aviation requests for PAPIs at all validated approaches.
- The accommodation of the installation of approach lighting systems at those runway locations where GPS approach procedures are planned to be initiated.

The programming and implementation of visual NAVAID projects are based on each of the nine FAA regions submitting qualified candidates and the review and validation of these requirements by the FAA Headquarters sponsoring organization within FAA funding guidelines.

In addition, the President's Task Force on aircrew complement recommended the installation of vertical guidance capability at all air carrier runways, and those locations not equipped with vertical guidance devices will receive priority consideration.

Products

- Current Capital Investment Plan (CIP) planning envisions the installation of 200 additional MALSRs, 300 REILs, 400 PAPIs, 200 ODALs, 20 ALSF-2s, and approximately 200 rigid approach lighting structure replacements in the FY94 and beyond time frame

H.5.9 Precision Runway Monitor (PRM) for Closely Spaced Parallel Runways

Responsible Division: ANR-300
Contact Person: Byron Johnson, 202/606-4644

Purpose

To assess and demonstrate the feasibility of applying Precision Runway Monitor (PRM) to increase the aircraft arrival rate at airports with closely-spaced parallel runways and develop the necessary equipment.

To develop the necessary equipment to apply PRM at airports with closely-spaced parallel runways.

An airport's capacity to handle arriving aircraft is limited by the number of runways that are usable at any one time. In instrument meteorological conditions (IMC), the number of usable runways depends on the spacing between the runways. Without PRM — an enhanced radar and an associated controller display — simultaneous (independent) approaches are only allowed if runways are spaced at least 4,300 feet apart. With PRM, the spacing required between closely spaced parallel runways is reduced to 3,400 feet. This change will allow more airports to conduct simultaneous independent approaches during inclement weather.

This project demonstrates the increases in an airport's arrival capacity that are possible with enhanced radar and controller displays. It will also produce a series of measurements on the effect of navigational accuracy, effect of the distance between the parallel runways, and response times of controllers, pilots, and aircraft. These measurements will also be useful for other similar applications such as runway spacings below 3,400 feet and triple and quadruple parallel runways.

Program Milestones

Two engineering models of secondary beacon radars were tested: an electronically scanned (E-scan) beacon radar capable of a 0.5 second update interval (compared with a 4.8 second update interval available from today's radars), and a system that uses Mode S monopulse processing on back-to-back beacon antennas mounted on a conventionally rotating ASR system, capable of a 2.4 second update interval. The demonstrations of both E-scan and Mode S, begun in 1989, used improved high resolution displays. Controller studies and flight test demonstrations were conducted in 1990.

In FY90-91, engineering models were successfully demonstrated in conducting independent IFR approaches to parallel runways spaced 3,400 feet apart. Simulations of independent parallel IFR approaches to runways spaced 3,000 feet apart using 1 mrad, 1 second update rate were conducted in FY91. Further research and development are underway for IFR approaches at spacings below 3,400 feet. Results are expected in the latter part of 1994.

Specifications have been incorporated into a limited production contract which was awarded for five E-Scan systems in March 1992.

Products

- Operational requirements definition
- Automatic blunder-detection algorithms
- Validated runway separation model
- Measured performance of displays, blunder-detection algorithms, and E-Scan and Mode S sensors
- Evaluation and procurement specification for production sensors or sensor modifications
- Operational procedures and guidelines